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SERIALS

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

Akademiya Nauk SSSR, *Izvestiya, Geologic Series*, in English translation (American Geological Institute). Washington, D.C.
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 American Association of Petroleum Geologists, *Bulletin*. Tulsa, Oklahoma.
 American Geological Institute, *AGI Data Sheet*. Washington, D.C.
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 Colorado School of Mines, *Mineral Industries Bulletin*. Golden.
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 Geokhimiya. *Geochemistry; a translation of the journal of the Academy of Sciences, U. S. S. R., devoted to geochemistry (Geochemical Society)*. Ann Arbor, Michigan.
 Geological Society of America, *Bulletin*. New York.
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 John Hopkins University, Dept. of Geology, *John Hopkins University Studies in Geology*. Baltimore, Maryland.
 Journal of Geological Education (National Association of Geology Teachers). Columbus, Ohio.
 Journal of Geology. Chicago.
 Journal of Metals (American Institute of Mining, Metallurgical and Petroleum Engineers). New York.
 Journal of Paleontology. Tulsa, Oklahoma.
 Journal of Petroleum Technology (Society of Petroleum Engineers). Dallas, Texas.
 Journal of Sedimentary Petrology. Tulsa, Oklahoma.
 Mineral Industries Journal (Virginia Polytechnic Institute). Blacksburg, Virginia.
 Missouri Speleology (Missouri Speleological Society). Columbia.
 Montana Bureau of Mines and Geology, *Bulletin*. Butte.
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 New Mexico, Bureau of Mines and Mineral Resources, *Bulletin*. Socorro.
 New Mexico, State Engineer Office, *Technical Report*. Santa Fe.
 Ohio, Division of Shore Erosion, *Technical Report*. Columbus.
 Oil and Gas Journal. Tulsa, Oklahoma.
 Ontario, Dept. of Mines, *Preliminary Map*. Toronto.
 Pacific Builder and Engineer. Seattle, Washington.
 Pennsylvania State University, Mineral Industries Experiment Station, *Bulletin*. University Park.
 Petroleum Week. New York.
 Physics of Fluids (American Institute of Physics). New York.
 Research Council of Alberta, Geological Division, *Bulletin*. Edmonton.
 Science. Washington, D.C.
 Soil Science. Baltimore, Maryland.
 Texas Petroleum Research Committee, *Bulletin*. [Corpus Christi?].
 U. S. Bureau of Mines, *Information Circular; Report of Investigations*. Washington, D.C.
 U. S. Geological Survey, *Bulletin; Circular; Miscellaneous Investigations Map; Trace Elements Memorandum Report*. Washington, D.C.
 U. S. Scientific Laboratory, Los Alamos, New Mexico, [Report].
 U. S. Snow, Ice and Permafrost Research Establishment, *Research Report; Technical Report*. Wilmette, Illinois.
 Washington Academy of Sciences, *Journal*. Washington, D.C.

PURCHASE OF PUBLICATIONS

Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

so: Geohydrology 2-1795.

5. Sloss, L. L., Edward C. Dapples, and Krumbein. LITHOFACIES MAPS, AN ATLAS OF THE UNITED STATES AND SOUTHERN CANADA: maps, tables, New York, John Wiley & Sons,

This atlas is the outgrowth of some 10 years of work by graduate students at Northwestern University in regional stratigraphic studies. Maps are reconnaissance type and are largely based on data from the stratigraphic literature and from aeromagnetic surface and subsurface information in the files of the Dept. of Geology. Quality of the maps is considerably in accordance with the abundance and accuracy of the available data. Tables of formation (p. 91-108) have been substituted for the charts of cross sections which originally accompanied each map or related group of maps. The tables are keyed by map number and page, of all rock units involved in each area of study represented by the map. By reference to the tables, the reader can determine the stratigraphic units involved at each point used in constructing the maps. The majority of maps are lithofacies maps showing areal variations in the lithologic attributes of the geologic units mapped. Facies are indicated by color and pattern on a base which includes state and province boundaries, the positions of the datum used, and, in heavy black lines, the isopach interval treated.--From pref. & intro.

6. Phemister, T.C., and J.A. Grant. DRYDEN TOWNSHIP, DISTRICT OF SUDBURY: Ontario, Dept. of Mines, Prelim. Map no. P.55, scale 1:63,360, lat. 50°30'-50°45'N., long. 90°-90°30'W., [1960].

Accompanying this preliminary geologic map of Dryden Township and the maps of Dryden, Broder, and other townships (see abstracts immediately below) is a 10-p. explanatory text, Notes on Geology of Dryden, Neelon, Dill, and Broder townships, Sudbury Geological Division, by J.A. Grant, W.J. Pearson, T.C. Phemister, and James E. Thomson. Text includes legend for the maps.

7. Pearson, W.J., T.C. Phemister, and James E. Thomson. DRYDEN TOWNSHIP, DISTRICT OF SUDBURY: Ontario, Dept. of Mines, Prelim. Map no. P.56, scale 1 in. to 1/4 mi., [1960].

8. Phemister, T.C., and I.D. MacGregor. BRODER TOWNSHIP, DISTRICT OF SUDBURY: Ontario, Dept. of Mines, Prelim. Map no. P.57, scale 1 in. to 1/4 mi., [1960].

9. Phemister, T.C., and J.A. Grant. DILL TOWNSHIP, DISTRICT OF SUDBURY: Ontario, Dept. of Mines, Prelim. Map no. P.58, scale 1 in. to 1/4 mi., [1960].

10. Canada, Geological Survey and Ontario, Dept. of Mines. NEVERFREEZE LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 920, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°30'-50°45'N., long. 90°-90°30'W., [1960].

2-1641. Canada, Geological Survey and Ontario, Dept. of Mines. MCCREA LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 921, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 50°45'-51°N., long. 90°-90°30'W., [1960].

2-1642. Canada, Geological Survey and Ontario, Dept. of Mines. OSNABURGH HOUSE, KENORA AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 922, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°-51°15'N., long. 90°-90°30'W., [1960].

2-1643. Canada, Geological Survey and Ontario, Dept. of Mines. OCHIG LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 923, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°15'-51°30'N., long. 90°-90°30'W., [1960].

2-1644. Canada, Geological Survey and Ontario, Dept. of Mines. TARP LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 924, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°30'-51°45'N., long. 90°-90°30'W., [1960].

2-1645. Canada, Geological Survey and Ontario, Dept. of Mines. MAMIEGOWISH LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 925, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 51°45'-52°N., long. 90°-90°30'W., [1960].

2-1646. Canada, Geological Survey and Ontario, Dept. of Mines. MENAKO LAKES, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 926, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°-52°15'N., long. 90°-90°30'W., [1960].

2-1647. Canada, Geological Survey and Ontario, Dept. of Mines. FORESTER LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 927, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°15'-52°30'N., long. 90°-90°30'W., [1960].

2-1648. Canada, Geological Survey and Ontario, Dept. of Mines. OPAPIMISKAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 928, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°30'-52°45'N., long. 90°-90°30'W., [1960].

2-1649. Canada, Geological Survey and Ontario, Dept. of Mines. WACHUSK LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 929, aeromagnetic map, contour intervals 10, 20, 100, and 1,000 gammas, scale 1:63,360, lat. 52°45'-53°N., long. 90°-90°30'W., [1960].

2-1650. McKee, Edwin D., and others. **PALEO-TECTONIC MAPS, TRIASSIC SYSTEM: U.S. Geol. Survey, Misc. Inv. Map I-300**, 33 p., 32 figs., 9 pls. incl. 7 maps, scale 1:5,000,000, 1959, pub. 1960, approx. 500 refs.

This folio is part of a series of paleotectonic maps which will summarize knowledge of each geologic system or period as represented in the United States. Maps included show rock thicknesses and gross facies relations of 3 subdivisions of the Triassic system, geology of the surface on which Triassic sediments were deposited, rock units resting directly on the Triassic system, and regional structures. The text interprets the maps, discusses major current problems, and indicates where additional information is needed.--U.S. Geol. Survey.

2-1651. Finch, Warren I., I.S. Parrish, and George W. Walker. **EPIGENETIC URANIUM DEPOSITS IN THE UNITED STATES: U.S. Geol. Survey, Misc. Inv. Map I-299**, scale 1:5,000,000, 3 sheets, 1959, pub. 1960.

All the epigenetic U deposits known in the United States are shown and are classified according to the age and type of host rock and the structural relation of the deposit to the host rock. The maps show the relation of the deposits to the distribution of 1) continental sedimentary rocks, 2) igneous and metamorphic rocks of pre-Late Cretaceous age, and 3) igneous rocks of Late Cretaceous and Cenozoic age.--U.S. Geol. Survey.

2-1652. Hemphill, W.R. **PHOTOGEOLOGIC MAP OF THE NOTOM-2 QUADRANGLE, WAYNE COUNTY, UTAH: U.S. Geol. Survey, Misc. Inv. Map I-302**, scale 1:24,000, lat. $38^{\circ}22'30''$ - $38^{\circ}30'N$, long. $111^{\circ}07'30''$ - $111^{\circ}15'W$, 1959, pub. 1960.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Sedimentary Petrology 2-1787; Mineral Deposits 2-1852.

2-1653. Geological Discussion Club, Vancouver, B.C. **GUIDEBOOK FOR GEOLOGICAL FIELD TRIPS IN SOUTHWESTERN BRITISH COLUMBIA**. Edited by W.H. Mathews: 53 p., 6 maps (geol. map in pocket, scale 1 in. to 8 mi.), 3 charts, secs., March 1960, 69 refs.

Guidebook was prepared by the Geological Discussion Club for the 1960 annual meeting of the Cordilleran Section, Geological Society of America. Papers and field trip guides are as follows:

Danner, Wilbert R. An Introduction to the Stratigraphy of Southwestern British Columbia and Northwestern Washington, p. 1-6.

White, William H. Granitic Rocks - Southwestern B.C., p. 7-10.

Mathews, W.H. Geomorphology, Southwestern British Columbia, p. 11-14.

Armstrong, J.E. Field Trip to Illustrate Geology of Coast Mountains, North Vancouver, B.C., p. 15-25.

Dolmage, V. Engineering Geology, North Vancouver, p. 26-32.

McTaggart, K.C., and others. Field Trip, Vancouver to Kamloops and Return, p. 33-52.

2-1654. Rossman, Darwin L. **GEOLOGY AND ORE DEPOSITS OF NORTHWESTERN CHICHAGOF ISLAND, ALASKA: U.S. Geol. Survey, Bull. 1058**, p. 139-216, 8 maps (5 in pocket incl. col. geol. map), scale 1:63,360, 3 graphs, 1959, 19 refs.

The area studied includes most of the northwestern part of Chichagof Island. The work, started in 1946, is a continuation of the geologic mapping done in the adjoining Chichagof mining district by Reed and Coats. The Au-bearing zone recognized by the writers continues through the area mapped to the northern shore of Chichagof Island.

Bedding rocks ranging in age from Paleozoic(?) through Early Cretaceous were intruded by gabbro, quartz diorite, norite-gabbro, and younger quartz diorite.

The major metamorphism and deformation occurred concomitantly with the intrusion of the diorite which is believed to have been contemporaneous with the orogeny during which the Coast Range batholith in the eastern part of southeastern Alaska was emplaced.

The oldest rocks, called the marble-gneiss sequence, probably of Paleozoic age, crop out in the northeastern half of the area. Within the mapped area blocks of rocks of this sequence are engulfed in the diorite and have been metamorphosed to gneiss, schist, and marble. Relatively unmetamorphosed, thin-bedded limestone, chert, black siltstone, and sandstone, probably the youngest rocks of the marble-gneiss sequence, crop out in a belt that extends from near Stag Bay SE. to the Chichagof mining district. These rocks underlie unconformably(?) a massive greenstone unit, which is considered to be the oldest unit of Mesozoic age in the mapped area.

The bedded rocks of Mesozoic age consist of 4 major units, all in apparent conformable relation to one another. From oldest to youngest they are called the greenstone, marble, schist, and graywacke units. The greenstone unit, probably of Triassic age, is composed of massive greenstone which is somewhat amygdaloidal in the upper part. The marble unit is composed of nearly pure marble. The schist unit is predominantly greenstone and metamorphosed siltstone but includes chert, limestone, and graywacke. The graywacke unit, of Early Cretaceous age, is dominantly graywacke with some siltstone, limestone, and, in the uppermost exposed part, greenstone. In certain areas the rocks in these units have been thoroughly recrystallized.

The igneous rocks from oldest to youngest are: gabbro, diorite, quartz diorite, the rocks associated with the Ni deposit, which include gabbro-norite and quartz diorite, and basalt. The diorite probably formed during Early Cretaceous time, and the gabbro is older. Much of the gabbro and diorite is believed to be recrystallized older rock. The oldest group of quartz diorite intrusives cuts the diorite, and is therefore younger. The quartz diorite is generally somewhat foliated and slightly metamorphosed.

The igneous rocks associated with the Ni deposit are the youngest of the major intrusive igneous rock groups. They intruded the graywacke of Cretaceous age after it had been folded to its present position.

Mafic and felsic dikes are present in almost equal proportions. They range in age from older than the diorite to younger than the youngest quartz diorite. Aplite dikes, the most abundant type, had their source in the older of the 2 quartz diorite intrusives. These dikes are intimately associated with most of the Au deposits in the area. Some of the pegmatite and quartz-feldspar dikes were prob-

GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

ly formed by replacement.

A mafic rock believed to be a basalt plug crops out on the N. shore of Lisianski Inlet. This body is probably the youngest igneous rock in the area. The bedded rocks in the area constitute the west flank of an anticlinorium which has been made structurally complex by the injection of large igneous intrusive masses. Near the SW. side of the area the rocks of Mesozoic age dip steeply southwestward and strike northwestward. N. of Lisianski Inlet, rocks of Paleozoic age are completely surrounded by granite.

Faults are widespread in the area. The best developed fault set strikes NW. and dips steeply to the NE. or SW. Along many of these faults the last movement had a strong horizontal component. Generally, evidence of displacement is lacking. A large fault along Lisianski Inlet appears to have caused the elevation of 5,000 ft. or more of stratified rocks of Mesozoic age N. of the inlet. Quartz diorite has been intruded along it at several places. The northward trending faults cut all the consolidated rocks, including the graywacke unit. A northeastward trending fault set also cuts the rocks of the mapped area, but the set is not as well developed as the northwestward trending set.

The northeastward trending faults have smaller displacements than the northwestward trending set and are important economically because it is along them that Au-bearing quartz veins have been found. Au is the most important mineral commodity mined to date. The Apex and El Nido are the 2 largest mines in the area; Au has also been recovered from the Goldwin and Cobol properties and in smaller amounts from other prospects. In addition to Au, the area includes Ni-bearing deposits at Mirror Harbor on Chichagof Island and at Bohemia basin on Yakobi Island. The area N. of Goulding Harbor contains Cu. The best area for prospecting, judging from the regional geology and the number and kind of quartz veins found, appears to be along a northward trending zone which extends from the head of Pinta Bay to the northern end of Althorp Peninsula. Auth.

2-1655. Nosow, Edmund, and Arthur C. McFarlan. **GEOLOGY OF THE CENTRAL BLUEGRASS AREA:** 51 p., 18 figs. incl. illus., maps, diags., Lexington, Kentucky Geological Survey, University of Kentucky, 1960, 28 refs.

This guidebook was prepared for the annual meeting, Southeastern Section, Geological Society of America, March 23-26, 1960.

The geology of the Bluegrass area has assumed much greater importance during the past year from the economic viewpoint. New Ordovician oil discoveries in the southern tier of counties bordering the Tennessee state line and additional testing of Ordovician potential reservoirs throughout the state have stimulated interest in Ordovician stratigraphy generally. Other than a few limited areas in S.-central Kentucky, the Ordovician outcrop coverage embraces S.-central Kentucky with its heart in the central Bluegrass region. The key to subsurface relationships is often established through study of surface outcrops, and the exposure of the oldest rocks in the state in the gorges of the Kentucky River make it an ideal site for study of these beds.

Structural relationships involving the Kentucky River and West Hickman fault systems further enhance the geologic importance of the area as a key to fault relationships elsewhere. The intersection

of these faults high on the Cincinnati arch and stratigraphic relationships of Paleozoic beds on both flanks of this structure provide interesting features to study in central Kentucky.--Auth.

2-1656. McGrain, Preston, and Thomas J. Crawford. **A PHYSIOGRAPHIC AND STRATIGRAPHIC PROFILE IN KENTUCKY - LEXINGTON TO THE MAMMOTH CAVE REGION:** 39 p., 28 figs. incl. map, secs., Lexington, Kentucky Geological Survey, University of Kentucky, 1960, 20 refs.

This field trip and guidebook were prepared for the 1960 annual meeting, Southeastern Section, Geological Society of America. Together they present a profile of Kentucky across several distinct physiographic divisions.

The route begins near the crest of the Cincinnati arch and extends southwest across the Inner Bluegrass, Eden shale belt, and Knobs belt, up the Highland Rim escarpment, and across the karst Mississippian plateau to the Dripping Springs escarpment. Outcropping rocks range in age from Middle Ordovician at Lexington to the Chester group (Upper Mississippian) at Mammoth Cave.

Topographic maps are used as a means of presenting land forms typical of each physiographic district. Text supplements the illustrations and attempts to explain the relationship between topographic expression and underlying bedrock. Some stratigraphic sections are included to acquaint the reader with the characteristics of formations encountered along the route.--Auth.

2-1657. Sando, William J., Robert B. Neuman, Morris Rones, Alan C. Donaldson, and C. E. Prouty. **GUIDEBOOK 3. LOWER PALEOZOIC CARBONATE ROCKS IN MARYLAND AND PENNSYLVANIA:** Johns Hopkins Univ., Dept. Geology, Johns Hopkins Univ. Studies in Geology, no. 18, 101 p., 17 figs. incl. maps, secs., tables, 1960, 42 refs.

A guidebook for the 1960 convention of the American Association of Petroleum Geologists, Atlantic City, New Jersey.

The Appalachians in Maryland and Pennsylvania were the site of predominantly carbonate sedimentation from Early Cambrian through Middle Ordovician time. Sedimentary structures, lithic associations, and other features indicate that through this long segment of time marine waters over most of this area were shallow and occasionally drained. Differences in both organic and inorganic controls from place to place through time gave rise to many different types and sequences.--Auth.

2-1658. Billings, Katharine Stevens. **GEOLOGY OF THE ISLES OF SHOALS:** 51 p., 6 illus., 7 maps, 6 secs., chart, 5 diags., Concord, New Hampshire State Planning and Development Commission, 1959, approx. 70 refs.

The Isles of Shoals, Maine-New Hampshire, consist of folded Ordovician through Devonian metamorphic rocks intruded by Middle Devonian diorite and granite. Pegmatites cut the granite, and trap dikes cut both the granite and metamorphics. Roof pendants are conspicuous features. Pleistocene glaciation scoured the rocks; marine erosion is now active.--M. Russell.

2-1659. Owens, James P., and James P. Minard. **GUIDEBOOK 1. THE GEOLOGY OF THE NORTH-**

CENTRAL PART OF THE NEW JERSEY COASTAL PLAIN: Johns Hopkins Univ., Dept. Geology, Johns Hopkins Univ. Studies in Geology, no. 18, 45 p., 5 maps, 6 tables, 1960, 24 refs.

A guidebook for a field trip of the 1960 convention of the American Association of Petroleum Geologists, Atlantic City, New Jersey. It describes the stratigraphy of late Cretaceous and Tertiary sedimentary rocks in the New Egypt, Columbus, Pemberton, and Brown Mills quadrangles of New Jersey.

The New Jersey Coastal Plain province is composed of a series of thin sheets of unconsolidated sands and clays with considerable quantities of gravel. Most gravel occurs in the Quaternary deposits, but some fine gravel is present in the lower beds (Raritan formation) of the Upper Cretaceous.

The Coastal Plain province has been divided into 20 mappable units. These formations range in age from Upper Cretaceous to Quaternary. The sedimentary rocks of the Coastal Plain do not show any profound structural deformation, except for a small southeastward tilt. It is probable, therefore, that they were deposited under relatively stable shelf conditions. The general change in strike of the successively younger groups to a more easterly direction suggests a long gradual uplift of the northwestern part of the coastal plain at least from late Cretaceous through Miocene time and probably into the Quaternary.

Tables summarize the literature on the stratigraphic relations of these rocks and show correlations with other areas.--O. Gates.

2-1660. Ballmann, Donald L. GEOLOGY OF THE KNIGHT PEAK AREA, GRANT COUNTY, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Bull. 70, 39 p., 10 figs., geol. map (in pocket), scale 1:63,360, 1960, 15 refs.

Precambrian granite, intruded by dikes of Precambrian diabase, is present on the NE. and SW. sides of the Knight Peak area.

Outliers of Cambrian-Ordovician Bliss sandstone and Ordovician El Paso limestone, of approximately the same thickness as these same units elsewhere in the Silver City region, suggest that the uplift of the Big Burro Mountains did not begin in Precambrian time.

An arkose, possibly of the Lobo(?) formation of Cretaceous(?) age, is present locally above the Precambrian granite.

Tertiary volcanic rocks, consisting of a lower rhyolitic series of lavas, tuffs and agglomerate, early andesitic lava and tuff, and middle rhyolitic breccia, lava, and tuffs, accumulated to a thickness of over 5,000 ft. Andesite was intruded locally along minor faults. Two large perlite bodies are among the early rhyolitic rocks.

Erosion in nearby areas furnished detritus for the lower beds of Gila conglomerate. Faulting along the Taylor fault on the NE. side of the area began at this time. Continued downward movement along this fault produced a basin in which the upper beds of the Gila accumulated. Greater displacement in the northern half of the area produced hinge faulting along the Malone fault, which bounds the northern half of the area on the W.

Several phases of late volcanic activity in Quaternary time produced rhyolitic cones and intrusive bodies, dacite lava, and andesitic lava and tuff, which overlies the tilted rocks of the Knight Peak area with an angular unconformity. Later Quaternary events

include the deposition of high-level gravels, pediment gravel, and alluvium. Dissection of the mountains and some crossfaulting continue to the present.--Auth.

2-1661. Baldwin, Brewster. GEOLOGY OF UNION COUNTY (In: Baldwin, Brewster, and William R. Muehlberger. Geologic studies of Union County, New Mexico: New Mexico, Bur. Mines & Mineral Resources, Bull. 63, pt. 1, p. 1-107, 6 pls. incl. col. geol. map, scale 1:125,000, 9 figs., 2 tables, 1959) 87 refs.

Union County, 3,817 sq. mi. in area, is in the NE. corner of New Mexico. Mesozoic formations recognized at the surface include the Baldy Hill formation (newly named), Travesser formation (newly named), Sloan Canyon formation, and Sheep Pen sandstone, all of the Triassic Dockum group; the Jurassic Exeter (Entrada) sandstone and Morrison formation; and the Cretaceous Purgatoire formation, Dakota formation, Graneros shale, Greenhorn limestone, Carlisle shale, and Niobrara formation. These units aggregate nearly 3,000 ft.

Undifferentiated upland deposits consist largely of the Pliocene Ogallala formation and include caliche and algal limestone. Basaltic rocks cover a fifth of the county and rest on upland deposits. The flows are subdivided into the Raton, Clayton, and Capulin units of Collins. However, the "type Clayton" may in fact be of younger Raton age. Capulin flows are Recent, whereas Raton flows are possibly of Pliocene age. About 80 volcanic centers, including cinder and shield cones, occur in aligned sets.

Locally, Exeter sandstone truncates open folds of the Dockum group. Mesozoic formations dip eastward from the Sierra Grande arch, with local interruptions by a monocline, an anticline, and other warpings. Possible warping in late Ogallala time may have triggered volcanic activity.

Mineral resources include scoria, gravel, and possibly clay. There has been intermittent production of carbon dioxide from wells; and of Cu from several pre-Exeter sandstone plugs.

A summary of subsurface stratigraphy, by Roy W. Foster, appears in the report, together with structure contour and isopach maps.--Auth.

2-1662. Muehlberger, William R. VOLCANIC ROCKS OF DES MOINES QUADRANGLE (In: Baldwin, Brewster and William R. Muehlberger. Geologic Studies of Union County, New Mexico: New Mexico Bur. Mines & Mineral Resources, Bull. 63, pt. 2, p. 109-157, 11 pls., 13 figs., 2 tables, 1959) 26 refs.

Late Cenozoic volcanic rocks cover about 725 sq. mi. of Union County. On geomorphic criteria, the basalts have been divided by earlier workers into 3 major groups: from oldest to youngest, the Raton, Clayton, and Capulin basalts. The Red Mountain dacites, pre-Clayton post-Raton local silicic differentiates found in several vents in Colfax County, have as their only possible representative in Union County, Sierra Grande, the largest volcano in this region.

The Des Moines 15-min. quadrangle and vicinity were mapped in detail. The stratigraphic sequence of basalts from 11 Clayton vents and 5 Capulin vents was determined. Petrographic, petrologic, paleomagnetic, and geomorphologic methods were used to correlate the volcanic rocks over the remainder of the county, because stratigraphic relationships could not be determined across the covered areas.

The volcanic sequence in Des Moines quadrangle

gan with the outpouring of the extensive Raton salt sheets that now cap the high mesas. No representative of the younger sequence of Raton basalts cognized to the W. of Union County is present. The thin sheets of undifferentiated Clayton basalt in central Union County may have erupted at the same time as the younger Raton episode of Colfax County. Chemical analyses support this view.

Eight new chemical analyses supplement earlier analyses; when used with fusion-index studies, petrographic data, volumes of eruption, and derived data (forms, etc.), they show a distinct trend of decreasing silica with time to the end of the Clayton sequence. The latest eruptions, the Capulin basalts, have the chemistry of the initial Raton magma but, unlike the Raton magmas, are of the cinder-cone rather than the fluid type.--Auth.

1963. Cady, Wallace M. STRATIGRAPHIC AND TECTONIC RELATIONSHIPS IN NORTHERN VERMONT AND SOUTHERN QUEBEC: *Geol. Soc. America, Bull.*, v. 71, no. 5, p. 531-576, 2 maps (fold.), fold. chart, 2 fold. secs., May 1960, 172 fs.

Stratified rocks of early and middle Paleozoic age form a belt of NE.-trending anticlinoria and synclinoria of middle Paleozoic age in northern Vermont and adjacent parts of southern Quebec. The foreland margin of this belt, in the Champlain and St. Lawrence valleys to the W., is cut by eastward-dipping thrust faults of middle Paleozoic age and by later E.-trending normal faults. The Green Mountain anticlinorium, which is the dominant structure of the region, is flanked to the W., on the foreland, by the St. Albans-Hinesburg-Middlebury synclinorium and to the E., in the midst of the folded belt, by the Connecticut Valley-Gaspé synclinorium. The principal thrust faults, notably the Champlain and Philipsburg thrusts, are in the W. limb of the St. Albans-Hinesburg-Middlebury synclinorium. E. of the Connecticut Valley-Gaspé synclinorium is the Boundary Mountain anticlinorium, in eastern Vermont and adjacent New Hampshire and along the international boundary between Quebec and Maine.

Two contrasting intergradational lithic assemblages, the graywacke-shale assemblage and the carbonate-quartzite assemblage, characterize the prothrust of the bedded rocks. The graywacke-shale assemblage includes thick sections of lower Paleozoic strata, portions of which lap both gradationally and unconformably westward on the foreland, particularly in Quebec; it also includes middle Paleozoic strata that offlap eastward away from the foreland. The carbonate-quartzite assemblage laps both conformably and gradationally eastward over the graywacke-shale assemblage in sections of the middle Paleozoic E. of the axis of the Green Mountain anticlinorium.

Stratigraphic correlation has become well established in the foreland belt where numerous distinctive and fossiliferous strata, chiefly of the carbonate-quartzite assemblage, have escaped metamorphism. It is also fairly clear in sections in the eastern foreland and western part of the Green Mountain anticlinorium, where the strata of the carbonate-quartzite assemblage extend eastward and interfinger with rocks of the graywacke-shale terrane. Rocks that are entirely of the graywacke-shale assemblage have been correlated in the present study.

The stratified rocks W. of the axis of the Green Mountain anticlinorium are of Cambrian(?), Cambrian, and Ordovician age; those to the E. range in age from Cambrian to Devonian.

The geotectonic setting of the region is the once mobile belt of the Appalachian orthogeosyncline, which is at the southeastern margin of the stable continental block, or craton, of North America. The orthogeosyncline was a belt, chiefly of subsidence, that embraced 2 parallel and adjoining longitudinal zones; the eugeosynclinal zone, which was more mobile, and the miogeosynclinal zone, which was less mobile. Second- and third-generation geosynclines are superimposed not only on the orthogeosyncline but also on adjoining parts of the craton.

Uplift, and finally folding, gradually superseded subsidence in the orthogeosyncline. Local uplift, chiefly within the eugeosynclinal zone, provided most of the clastic sediments, principally those of the graywacke-shale assemblage. General stabilization of the western part of the orthogeosyncline at the end of the Ordovician was accompanied by eastward migration of the miogeosynclinal zone. Localized uplift within the eastern part of the orthogeosyncline at this time is marked by unconformities referred to the Taconic disturbance. Folding and uplift after the Early Devonian is shown by angular unconformities referred to the Acadian and Appalachian orogenies.

The interpretation of the geotectonic relations of the bedded rocks is aided by critical features of the magmatic activity that began with, accompanied, and followed the diastrophism.--Auth.

2-1964. Cooper, Byron N. GUIDEBOOK 2. THE GEOLOGY OF THE REGION BETWEEN ROANOKE AND WINCHESTER IN THE APPALACHIAN VALLEY OF WESTERN VIRGINIA: Johns Hopkins Univ., Dept. Geology, Johns Hopkins Univ. Studies in Geology, no. 18, 84 p., 18 figs., incl. maps, secs., 1960, 52 refs.

A guidebook for a field trip of the 1960 convention of the American Association of Petroleum Geologists, Atlantic City, New Jersey. It summarizes the Paleozoic stratigraphy and structure of the Shenandoah valley region with numerous maps and stratigraphic sections.

The Paleozoic section extends from Cambrian to Mississippian. Lower Cambrian quartzites and shales, unconformably overlying Precambrian gneisses, grade upwards into at least 10,000 ft. of limestones and dolomites ranging from Middle Cambrian to Middle Ordovician in age. These are overlain by shales and sandstones and a few conglomerates of Upper Ordovician, Silurian, and Devonian age. The youngest Paleozoic rock described is the Mississippian Pocono formation.

The structure consists of 3 principal folded thrust faults, the Blue Ridge, Pulaski, and North Mountain.--O. Gates.

2-1965. Ranneft, T.S.M., Roy M. Hopkins, Jr., Albert J. Froelich, and John W. Gwinn. RECONNAISSANCE GEOLOGY AND OIL POSSIBILITIES OF MINDANAO: Am. Assoc. Petroleum Geologists, *Bull.*, v. 44, no. 5, p. 529-568, 5 illus., 9 maps, sec., 2 charts, diag., May 1960, 27 refs.

Mindanao is part of an island arc system which includes the Philippines and eastern Indonesia. The geologic structure of the island is reflected by the physiography. The structural features in eastern Mindanao are northerly aligned and are strongly influenced by the active Philippine rift; those of western and central Mindanao reflect a merging of diverse tectonic and volcanic trends. The mountainous areas consist chiefly of basement and Tertiary

volcanic rocks, whereas intervening lowlands are underlain by Tertiary sedimentary rocks. There are 2 major sedimentary basins - the Agusan-Davao trough and the Cotabato basin - which contain 6,000-15,000 ft. of marine strata of geosynclinal origin. The stratigraphic succession is composed mostly of Miocene and Pliocene rocks which are characterized

by abrupt lateral and vertical lithologic changes. In addition, a thick Eocene limestone is present in the Agusan-Davao trough. There are possibilities for commercial hydrocarbon accumulation in both basins. The sedimentary section contains probable source, cap, and reservoir rocks, and potential structural and stratigraphic traps are present. --Auth.

2. GEOMORPHOLOGY

See also: Stratigraphy 2-1703; Mineralogy 2-1762, 2-1763; Sedimentary Petrology 2-1776; Mineral Deposits 2-1847; Engineering Geology 2-1892, 2-1893.

2-1666. Strahler, Arthur N. **PHYSICAL GEOGRAPHY**: 2d ed., 534 p., illus., maps, diags., graphs, New York, John Wiley & Sons, 1960, approx. 1000 refs.

In 4 parts: 1) The earth as a globe, 2) The weather elements, 3) Climate and soil, and 4) Landforms. Topics covered in the section on landforms include: rocks and their structures; earth's crust; water in soil and rock; wasting of slopes; runoff; landforms made by streams; cycle of land-mass denudation; landforms made by glaciers, by waves and currents and by wind; coastal plains, horizontal strata, domes; folds, faults, and fault blocks; crystalline masses and volcanic forms. Changes from the 1951 edition include new chapters devoted to soil moisture, ground water and surface runoff. This textbook is designed for introductory courses in colleges and universities. --A. C. Sangree.

2-1667. Culling, W. E. H. **ANALYTICAL THEORY OF EROSION**: Jour. Geology, v. 68, no. 3, p. 336-344, 5 diags., May 1960, 13 refs.

A mathematical theory of erosion is developed along similar lines to the classical Fourier theory of heat flow in solids. The general theory is considered in some detail, and a few representative examples of its application to stream profiles and valley slopes are suggested in outline. --Auth.

2-1668. Hopkins, David M. **SOME CHARACTERISTICS OF THE CLIMATE IN FOREST AND TUNDRA REGIONS IN ALASKA**: Arctic, v. 12, no. 4, p. 214-220, map, graph, table, Dec. 1959, pub. 1960, 15 refs.

In order to assess the paleoclimatic significance of fossil plant assemblages of Pleistocene age found in Alaska, temperature records from the 78 Alaska weather stations that have been in operation for 10 years or more were analyzed and compared with the vegetation at the station. A good correspondence was discovered between the vegetation at the station and the number of degree-days above 50°F. on one hand and the mean temperature of the coldest month on the other. (The number of degree-days above 50°F. was approximated by multiplying the amount by which the mean temperature of the warmer months exceeded 50°F. times the number of days in the warm months).

All weather stations in either the coastal Sitka spruce-hemlock forest or the interior white spruce-birch forest record more than 130 degree-days above 50°F., and nearly all weather stations beyond or above the limit of forest record less than 130 degree-days above 50°F. Nearly all weather stations within the interior forest report at least one winter month during which the mean temperature is lower than

10°F., and nearly all stations in the coastal forest report no winter months having a mean temperature as low as 15°F. Thus, fossil remains of coastal Sitka spruce-hemlock forest suggest past periods of warm summers and mild winters, fossil remains of interior white spruce-birch forest suggest past periods of warm summers and severe winters, and fossil remains of tundra vegetation suggest past periods of cold summers and either mild or severe winters. --Auth.

2-1669. **GLACIOLOGICAL NOTES**: no. 1, Jan. 1960, New York, IGY World Data Center A: Glaciology, American Geographical Society, 1960-, in progress. Supplement A. Glaciological Activities, 1959: 19 p., Jan. 1960.

The first in a series of information bulletins to be issued quarterly in 1960 to provide information about current activities, studies, and publications of glaciological interest, and to describe the operations and facilities of the IGY World Data Center A: Glaciology, so that it may effectively perform its role as an archive and clearing house of information. Supplement A is a summary of glaciological activities undertaken throughout the world in 1959. The information is organized on a regional basis. --M. Russell.

2-1670. Butkovich, Theodore R. **THE FLOW LAW FOR ICE**: U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 56, 7 p., 4 diags., 2 tables, Aug. 1959, 18 refs.

The result of laboratory creep tests in a shear apparatus at -5°C. on 2 x 2 x 3/8 in. samples of commercial ice, artificial single crystals, and 6 types of ice from the Greenland ice cap, at shear stresses of about 0.5 - 3 kg./cm.² are reported. Some uniaxial tests were made at stresses from 6 - 28 kg./cm.² to supplement the shear tests. Creep data could usually be represented approximately by one or more linear sections on a log-deformation vs. log-time plot. The linear sections of the double logarithmic curve imply a creep curve of the form $\epsilon = ct^m$, where ϵ is the strain. For all samples tested, except single crystals sheared in easy glide, m averaged 0.5 for shear deformations up to about 1%, and approached unity for more deformation. For single ice crystals oriented for easy glide, m averaged 1.7, implying a strain softening. Single crystals oriented for hard glide behaved similarly to polycrystals, indicating a rate-controlling process such as dislocation climb. For all but single easy-glide crystals, the minimum creep rate was tangent to the deformation curve at the end of the experiment. Creep rates for single easy-glide crystals were several hundred times larger than for the other crystals, the flow laws being similar. --Auth. summ.

2-1671. Butkovich, Theodore R. **ON THE MECHANICAL PROPERTIES OF SEA ICE, THULE,**

STRUCTURAL GEOLOGY

1672. EENLAND, 1957: U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 54, 11 p., diag., Aug. 1959, 6 refs.

The investigations on sea ice, conducted at Thule, Eeenland, during Feb. and March 1957 included: confined compressive strength, ring tensile strength, and flexural strength tests on simple beams both horizontal and vertical test specimens. Additional tests were made to determine the modulus of elasticity with the simple beams in flexure. Tests were also made for creep in uniaxial compression. Although there is a high scatter of results, a dependence of strength and creep on temperature and brine volume is evident. Higher compressive, tensile, and flexural strengths, along with higher values of the elastic modulus were obtained at lower temperatures or brine volumes. The minimum creep rate decreases with decreasing temperature and brine volume.--Auth. summ.

1672. Lee, Hulbert A. LATE GLACIAL AND POSTGLACIAL HUDSON BAY SEA EPISODE: *Science*, v. 131, no. 3413, p. 1609-1611, map, diag., July 27, 1960, 12 refs.

Geological investigations, archeological studies, and radiocarbon dates indicate a similarity of events around Hudson Bay, commencing at the time Hudson Bay basin was freed of glacier ice. The sea that then spread around Hudson Bay 7,000 to 8,000 years ago were named "Tyrrell sea." The subsequent rate of land emergence decreased exponentially.--Auth.

1673. Lewis, D.W. HEAVY MINERAL CONTENT OF TILLS IN WESTERN NEW YORK: *Compass*, v. 3, no. 3, p. 162-173, map, 4 tables, March 1960, 1 refs.

This paper discusses partial heavy mineral analyses of a scattering of till samples from western New York, following the procedure established by A. Heimann in adjacent Ontario. [The study was undertaken to investigate adequacy of the analyses and application to solution of glacial problems]. Systematic variations in purple to red garnet ratios and carbonate contents in tills of early Cary, late Cary, and Valders are found indicating modifications correlated with respect to increasing distance from the source areas of the heavy minerals. Less consistent are total heavy mineral, magnetic mineral, pyrite, and marcasite and total garnet percentages. The source of the heavy minerals is in the Canadian Shield, N. of Ottawa-Montreal. In general, within each group of tills, the heavy mineral content decreases with increasing distance from the source.--Auth.

1674. Foxworth, W.R. MONTMORILLONITE CLAY: A WEATHERING FACTOR: *Compass*, v. 37, no. 4, p. 315-318, 2 illus., May 1960, 8 refs.

The subject of mechanical weathering and exfoliation of rock has been explained in several ways by various writers. The writer proposes and cites evidence that the hydration of montmorillonite clays is an important factor in the disintegration of silicic rocks.--Auth.

2-1675. Vann, John H. LANDFORM-VEGETATION RELATIONSHIPS IN THE ATRATO DELTA: *Assoc. Am. Geographers, Annals*, v. 49, no. 4, p. 345-360, 7 illus., 4 maps, Dec. 1959, approx. 6 refs.

The delta of the Atrato River in northwestern Colombia exhibits physical features which permit recognition of relationships between its landforms, hydrography, and vegetation. These features are vegetative, a distinctive flora persists as an indicator of past landform alterations. The zoning of certain species of grasses, bushes, and trees by drainage variations is clear, and once established on a given piece of land, will remain for some time after the initial conditions are changed. These observations took place in a tropical delta region and, since they correlated with other similar areas, could be used to interpret both direct observations and aerial photographs.--C. W. Schreiber.

2-1676. Ewing, Maurice, and Bruce C. Heezen. CONTINUITY OF MID-OCEANIC RIDGE AND RIFT VALLEY IN THE SOUTHWESTERN INDIAN OCEAN CONFIRMED: *Science*, v. 131, no. 3414, p. 1677-1679, map, profiles, table, June 3, 1960, 8 refs.

The existence of a continuous, rifted, mid-oceanic ridge in the southwestern Indian Ocean, previously predicted by the authors has been confirmed by soundings taken by the research vessel *Vema* during the expedition now in progress.--Auth.

2-1677. Gravenor, C.P., Robert Green, and John D. Godfrey. AIR PHOTOGRAPHS OF ALBERTA: *Research Council Alberta, Geol. Div., Bull.* 5, 38 p., 47 illus., 2 maps, 3 secs., 1960, refs.

Selected air photographs are used to illustrate some of the landforms and geologic features of the Precambrian Shield, Plains and Foothills regions, and the Rocky Mountains of Alberta. Features illustrated and described include preglacial and drift-filled valleys; ice-walled and ice-marginal channels; linear features of glaciation; various types of moraine; erosional and depositional features of mountain glaciation; eskers; lacustrine features; slump and landslides; dunes; karst topography; faults and folds of various types; and topographic expressions of sedimentary, metamorphic, and igneous rock units ranging in age from Precambrian to Pleistocene.

The plates, 8 by 11 in., comprise air photographs mounted in stereo-pairs or stereo-triplets for use with a hand stereoscope.--R. Green.

3. STRUCTURAL GEOLOGY

Also: *Geologic Maps* 2-1650; *Areal and Regional Geology* 2-1663; *Geomorphology* 2-1676; *Stratigraphy* 2-1675, 2-1701; *Fuels* 2-1879.

1678. Bell, Alfred H. HOW CAN DUPLICATION OF NAMES OF MAJOR STRUCTURAL FEATURES BE AVOIDED?: *Am. Assoc. Petroleum Geologists, Bull.*, 44, no. 4, p. 500-501, Apr. 1960.

Examples of duplication of names for major structural features are quite common in the literature. In addition to reviewing previous literature, all authors publishing a map or article in which a structural feature is named for the first time should consult the revised tectonic map of the United States.--I. M. Johnston.

2-1679. Kupfer, Donald H. PROBLEMS OF FAULT NOMENCLATURE: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 4, p. 501-505, 5 figs., Apr. 1960, 5 refs.

The problems of fault nomenclature are discussed, and the terms "net slip" and "shift" are defined. Fault nomenclature needs general as well as specific terms. It is suggested that "normal" and "reverse" be defined in more general terms.

The foremost job of a committee on fault nomenclature would be to set up 10-20 terms, some general, some specific, which can be put into general texts for beginning students.--I.M. Johnston.

2-1680. Menner, V.V., and M.E. Raaben. ON THE NATURE OF SMALL FOLDS IN THE MESOZOIC OF THE EASTERN TIMAN AREA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 6, p. 69-72, map, secs., pub. Apr. 1960, 7 refs.

English translation of GeoScience Abstracts 1-85.

2-1681. Probandt, William T. RECONNAISSANCE INVESTIGATION - PARADOX BASIN SALT STRUCTURES AND MOAB VALLEY, UTAH: Compass, v. 37, no. 4, p. 251-268, 2 illus., 2 maps, diagrs., May 1960, 16 refs.

A series of parallel-trending collapsed anticlines, underlain by a thick evaporite section, are located in the Paradox basin region of Utah and Colorado. Similar structural and sedimentary relationships, and the evidence of tectonic influence from a zone of major folding and faulting, indicate a common, localized mode of origin for these salt structures. A deep-seated belt of parallel folds probably controlled the linearity of the structures, and the mobile front of the monoclinical Uncompahgre uplift probably transmitted deformational pulses into the Paradox basin.

A detailed review of theories and conclusions gained from previous investigations is presented in conjunction with a reconnaissance study of Moab Valley, a typical Paradox basin salt structure. The conclusions of this study are deemed broadly applicable to any of the companion Paradox basin salt structures.--Auth.

2-1682. Yeats, V.L. UPHEAVAL DOME: Compass, v. 37, no. 4, p. 269-277, illus., 2 maps, chart, May 1960, 18 refs.

The Moab region, southeastern Utah, is an area of diversified scenic and geologic features, with Upheaval dome probably the most spectacular feature. The origin of the dome remains a problem, but hypotheses have been advanced attributing it to igneous intrusion, salt flowage, or a combination of the two. It has also been classified as a cryptovolcanic structure. Several drill holes should be made to obtain information leading to a better understanding of complex, domal structure.--Auth.

2-1683. Pavlovsky, E.V. BRIEF OUTLINE OF THE PRECAMBRIAN AND LOWER PALEOZOIC OF THE SCOTTISH HIGHLANDS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 6, p. 19-39, map, 4 secs., table, pub. Apr. 1960, 40 refs.

Pt. 1 of a 2-pt. article on the Caledonian Mountains of Scotland.

There are reasons for regarding Great Glen, the Moine thrust, and the Border fault as deep-seated plutonic faults, dislocations which as early as Precambrian and early Paleozoic time broke up the territory of the Scottish mountains into a number of blocks extending in a NE. direction. From the NW. to the SE. of the ancient Eria platform these blocks are as follows: Northern Highlands, Grampian Highlands, and, outside the area of the present article, the "Midland Valley" block.

Structure and stratigraphy of the Eria Precambrian platform, the Northern Highlands block, and the Grampian Highlands block are described.--From auth. introd.

2-1684. Sinitsyn, N.M., and V.M. Sinitsyn. PRINCIPAL TECTONIC ELEMENTS OF TIEN-SHAN: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 1-13, map, pub. Feb. 1960, 15 refs.

This paper deals with the tectonics of the Tien-Shan mountain system within its orographic boundaries, including its Soviet and Chinese portions. The general regional structural plan of the Tien-Shan is given, as well as a brief description of the folded province and of zones of different ages.--Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 2-1635, 2-1650; Areal and Regional Geology 2-1657, 2-1663; Structural Geology 2-1683; Paleontology 2-1713, 2-1714, 2-1715; Igneous and Metamorphic Petrology 2-1769; Sedimentary Petrology 2-1777, 2-1785, 2-1789; Geohydrology 2-1792, 2-1793; Fuels 2-1871.

2-1685. Markov, M.S. THE STRATIGRAPHY AND TECTONIC POSITION OF JASPILITE STRATA OF THE KARSAPAY SYNCLINORIUM: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 24-39, 5 figs., pub. Feb. 1960, 35 refs.

This study is concerned with the structure and tectonic arrangement of Fe quartzite beds in the Precambrian of the southern part of the Ulutau [central Kazakhstan]. Two types of jaspilite formations are distinguished, with a discussion of their similarity and differences.--Auth.

2-1686. Krivtsov, A.I. LATEST DATA ON THE LOWER PALEOZOIC OF THE EAST SLOPE OF THE BALTIC SHIELD: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 55-65, map, secs., table, pub. Feb. 1960, 6 refs.

Normal Precambrian (Sinian)-lower Paleozoic sediments are well developed over the northwestern Russian platform.

Genetically, and from their stratigraphic relationship, a binary subdivision of these deposits, into what appears to be the correlatives of the lower and upper divisions of the Sinian system, appears to be most natural. The lower Sinian period was characterized here chiefly by littoral-continental conditions of sedimentation (represented by the ancient weathered crust of crystalline basement rocks and a thick sandy section of the Nenoksa formation), while the upper Sinian epoch is represented chiefly by littoral marine argillites of the Ust-Pinega formation.

A littoral-marine sedimentary environment, with very unstable shoreline, persisted here throughout the Lower Cambrian. But as early as the close of this epoch, the sea retreated from the subject area, and a vast stretch of the northwestern European S. S. R. stood high until the onset of a Lower Ordovician transgression.--Auth. summ.

1687. Lyubtsov, V.V. NEW FINDINGS AND THE STRATIGRAPHIC POSITION OF *TOLMACHOVIA CONCENTRICA* KOBAYASHI (CLASS CRUSTACEA) FROM THE ORDOVICIAN OF EAST SIBERIA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 75-76, 2 illus., pub. Feb. 1960, 2 fs.

Deposits containing *Tolmachovia concentrica* had been formerly assigned to Middle Ordovician. As the result of new data, they are now considered to belong to the Chun stage of the Lower Ordovician. The wide lateral and narrow vertical distribution of *T. concentrica* throughout the Ordovician of eastern Siberia makes it an outstanding index fossil.--A. C. Angree.

1688. Kushnarev, I. P., and A. B. Kazhdan. STRATIGRAPHY OF THE MIDDLE PALEOZOIC EXTRUSIVE SERIES OF THE SOUTHWESTERN SLOPES OF NORTH TIEN SHAN: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 5, p. 88-104, map, pub. March 1960, 13 refs.

Stratigraphic problems of middle and upper Paleozoic extrusive rocks of the southwestern slopes of northern Tien Shan are considered. The authors criticize the generally accepted scheme of N. P. Sil'kovsky and offer several considerable changes and refinement of his classification.--Auth.

1689. Kinzikeyev, A. R. KYNOV BEDS OF THE DEVONIAN IN BASHKIRIA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 79-81, pub. Feb. 1960, 2 refs.

Deposits now taken to be Kynov in Bashkiria, are not correlative with those along the W. slope of the Urals. The deposits of the first primary rhythm - from the base of the "upper limestone" to the base of the so-called "middle Kynov" limestone - are equivalent to the Pashiisk beds of the W. slope of the Ural. Lyashenko scheme for the central provinces of the Russian platform.

The Kynov beds, in their most complete sections, may be divided into 2 individual stratigraphic units: the lower Kynov beds, characterized by a fauna of *Orthispirifer nalikini* Ljasch., *Schizophoria kremskii* Ljasch., and correlative with the lower multicolored unit of the Timan Nefteol formation, and with the Archedinsk unit of the central Russian platform; and the upper Kynov beds characterized by a fauna of *Orthispirifer timanicus* Ljasch., *Hypothyridina resmilukiana* Ljasch., and correlative with the upper multicolored unit of the Timan Nefteol formation and the Kikin unit of the central Russian platform Devonian, as given by the A. I. Lyashenko scheme.--Auth. concl.

1690. Sokolova, E. A. UPPER DEVONIAN AND LOWER CARBONIFEROUS DEPOSITS AND ASSOCIATED IRON-MANGANESE ORES OF THE DZHAILMA SYNCLINE (ATASUY REGION OF CENTRAL KAZAKHSTAN): Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 5, p. 25-38, 1 illus., map, 2 tables, pub. March 1960, 14 refs.

Three genetic types of Upper Devonian and lower Carboniferous deposit are distinguished by the author in the Dzhalma syncline. The characteristics of each type are described, and special attention is devoted to deposits associated with the ferromanganese ores of Karadzhal. A few considerations dealing with the genesis of these ores are stated.--Auth.

2-1691. Ferm, John C., and E. G. Williams. STRATIGRAPHIC VARIATION IN SOME ALLEGHENY ROCKS OF WESTERN PENNSYLVANIA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 4, p. 495-497, 3 secs., table, Apr. 1960, 2 refs.

Recent stratigraphic studies of Allegheny rocks [Pennsylvanian] of western Pennsylvania seem to show that the marine Kittanning rocks are analogous with Freeport rocks of fresh-water origin. Detrital sediments dominate Allegheny rocks but nondetrital coals, ironstones, and limestones do occur and they separate detrital facies. The couplets of detrital and non-detrital rocks can be considered as records of cyclic sedimentation.--I. M. Johnston.

2-1692. Ross, Charles A. THE WOLFCAMP SERIES (PERMIAN) AND NEW SPECIES OF FUSULINIDS, GLASS MOUNTAINS, TEXAS: Washington Acad. Sci., Jour., v. 49, no. 9, p. 299-316, 2 figs., 4 pls., Nov. 1959, 6 refs.

The standard Wolfcamp series (lower Permian), Glass Mountains, Texas, is represented by a sequence of diverse lithologies representing complex facies and includes a regional unconformity. The base of the Wolfcamp series is raised to exclude strata of late Pennsylvanian age (i.e., the "Uddenites shale" and Bed 2 of the "gray limestone" of King), and the top is raised in the eastern Glass Mountains to include strata previously placed in the lower part of the Leonard series. Two formations can be recognized in the field and both are within the "zone of *Pseudoschwagerina*." Each formation has a distinct and characteristic fusulinid fauna.

The Nealranch formation embraces the upper part of beds originally called Wolfcamp by Udden in the Wolf Camp Hills and is renamed to retain Wolfcamp for the series name. The fusulinids which characterize and are restricted to the Nealranch formation in the Wolf Camp Hills include: *Triticites uddeni*, *Pseudoschwagerina uddeni*, *Paraschwagerina acuminata*, *P. gigantea*, *Schwagerina emaciata*, and the new species *S. pugunculus*. In addition, the following species range into the Nealranch formation: *Triticites ventricosus*, *T. pinguis*, *T. koschmanni*, *Pseudoschwagerina beedei*, and *P. texana*.

The Lenoxhills formation unconformably overlies the Nealranch formation and is the upper formation of the Wolfcamp series in the Glass Mountains. Fusulinids which characterize and are restricted to the Lenoxhills formation in the western Glass Mountains include: *Schwagerina laxissima*, *S. bellula*, *Pseudoschwagerina robusta*, and 4 new species, *Schwagerina extumida*, *S. lineanoda*, *S. dispansa*, and *Pseudoschwagerina tumidosus*. In addition, the following species range into the Lenoxhills formation: *Schwagerina compacta*, *S. nelsoni*, *S. knighti*, *S. diversiformis*, *Pseudoschwagerina beedei*, *P. Texana*, *Parafusulina linearis*, *P. schucherti*, and the 3 new species, *Schwagerina tersa*, *S. crebrisepeta*, and *Paraschwagerina plena*.--Auth.

2-1693. Cazeau, Charles J. CROSS-BEDDING DIRECTIONS IN UPPER TRIASSIC SANDSTONES OF

NORTHEASTERN NEW MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 5, p. 638-640, 2 maps, diag., May 1960, 8 refs.

This reconnaissance investigation of cross-bedding directions reveals that Upper Triassic sediments in northeastern New Mexico may have had their source in positive areas on the S. and SE. An alternative interpretation of the data shows that sediment contributions from S.-central Colorado, a presumed major source area, cannot be completely ruled out, but it appears that the S.-central Colorado area was not a chief source of supply. An expansion of cross-bedding studies in conjunction with detailed petrographic analysis of the Dockum sandstones would probably clarify the problem of types and sources of sediment for these beds during Late Triassic time.--Auth. concl.

2-1694. Frebold, Hans, Eric Walter Mountjoy, and Ruth Reed. **THE OXFORDIAN BEDS OF THE JURASSIC FERNIE GROUP, ALBERTA AND BRITISH COLUMBIA:** Canada, Geol. Survey, Bull. 53, 47 p. 12 pls., 6 maps, 2 tables, 1959, 42 refs.

The Oxfordian beds of the Jurassic upper Fernie group occur at many places in the Foothills and eastern Rocky Mountains between the International Boundary in the S. and the Peace River country in the N. Their lower part (unit a) consists of glauconitic silt or sandstone and shale (Green beds), their upper part of dark shale with rusty weathering bands and concretions (unit b¹) or dark shale with sandstone bands (unit c¹ = lower part of Passage beds). Unit b¹ is the northern equivalent of unit c¹ which is characteristic of the S.

The Green beds are normally underlain by the lower Callovian Grey beds, but locally they lie on the middle Bajocian Rock Creek member. They form an excellent horizon marker, both where they outcrop and in the subsurface. In the southern sections they are 50 to 60 ft. thick. In the N. (Rocky River sections) they consist of 2 glauconite beds, separated from each other by 50 to 60 ft. of shale with concretions. These beds contain Cardiocerata of early Oxfordian age. Unit b¹ and the uppermost part of unit a in the S. contain *Buchia concentrica* (Sowerby) which indicates a late Oxfordian or early Kimmeridgian age.

In the western interior of the United States and in the southern plains of Canada the equivalent of the Oxfordian part of the Fernie group is the Swift formation.

The Oxfordian beds of the Fernie group were deposited in the Logan sea, which transgressed over parts of western Canada after the late Callovian period of regression. The Canadian part of the Logan sea was probably connected with the sea in British Columbia, and through it, with the Pacific Ocean. After the time of the late Oxfordian or early Kimmeridgian the sea began to retreat in the western interior of the United States, where the nonmarine beds of the Morrison formation were deposited. During this time marine conditions still prevailed in the Canadian part of the former Logan sea and there the final regression took place not earlier than in late Portlandian time.--Auth.

2-1695. Kochetkov, T.P. **NEW DATA ON THE STRATIGRAPHY OF CRETACEOUS COAL MEASURES IN THE LENA BASIN:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 40-47, 2 tables, pub. Feb. 1960, 4 refs.

A correlation of the paleobotanical units of the Chay-Tumuss and Bulun sections of the Cretaceous coal measures exposes an error made by A.I. Gusev in his correlation of the Olenek and Bulun sections. As a result of this error and of an erroneous assignment of the upper part of the Olenek coal measures to the Upper Cretaceous, the volume of the Olenek Lena sequence was artificially restricted, which led to the designation of a so-called "Olenek" sequence comprising the analogues (Lukumay, Ukin formations) of the upper Lena sequence in the area of the course of the lower Lena.

These errors are reflected in a general stratigraphic scheme of the Lena coal basin, where the erroneously designated "Olenek" sequence is given a regional significance. In order to eliminate this error, the author proposes to abandon the term, "Olenek series," and subdivide the Cretaceous Lena basin sediments into 2 series: Lower Cretaceous-Lena, and Upper Cretaceous-Vilyuy.--Auth. summ.

2-1696. Logachev, N.A. **CONTINENTAL CENOZOIC DEPOSITS IN BAIKAL TYPE BASINS:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 14-23, map, 3 secs., table, pub. Feb. 1960, 16 refs.

Throughout the Sayan-Baikal highlands, Cenozoic sedimentation is separated from the Mesozoic, both in space and in time. This paper offers the first regional stratigraphic classification of Cenozoic deposits for the Baikal-type basins and discusses the ancient weathering processes. Sediment accumulation occurred in stages differing in tectonics, relief, and climate. The stratigraphic zonation of autochthonous formations, reflecting a chemical differentiation in the course of time, is determined by the process of chemical weathering of the crystalline basement silicates in the source areas.--Auth.

2-1697. McGookey, Donald P. **EARLY TERTIARY STRATIGRAPHY OF PART OF CENTRAL UTAH:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 5, p. 589-615, 8 illus., 3 maps, sec., 3 tables, May 1960, 32 refs.

Between Peterson Creek and Gooseberry Creek, SE. of Salina, Utah, a 7,800-ft.-thick section crops out that records post-Laramide events from the latest Cretaceous to early middle Tertiary. The preservation of this section is the result of a consistently low structural position through recurring regional uplifts of adjacent areas. The description of this Tertiary section supplements the excellent record of Laramide events obtained by studies of the complete Cretaceous section in the Wasatch plateau area.

The section described begins with the North Horn formation, which records piedmont and succeeding lowland environments during contemporaneous orogenic activity farther W. The upper North Horn lacustrine shale sequence indicates the first inundation of this area by the early Tertiary Uinta Lake. The lake remained continuously while the Flagstaff limestone, Colton shale, and Green River shale and limestone were deposited, a continuous Paleocene to middle Eocene section totaling more than 2,300 ft. The lake withdrew because of post-Green River, pre-Crazy Hollow (late middle Eocene) positive movements, and erosion removed varying thicknesses of Green River prior to deposition of fluvial Crazy Hollow shale and sandstone. Central Utah was inundated again in the late Eocene by a lake. Volcanic activity on the S. or SW. at this time

ed a fairly steady rain of fine pyroclastic mater-
ing deposition of the Bald Knoll formation;
ased activity provided coarser debris for the
ng Vat formation (new name). The late Eocene
withdrew, and mudflows and conglomeratic tuf-
us sandstone of the Bullion Canyon volcanics
deposited. These sediments were derived
erosion of nearby volcanoes and represent the
of a nearly continuous sedimentary succession
entral Utah from Jurassic to middle Tertiary.
neous extrusives (Bullion Canyon lava flows)
ted almost all the subject area in the early mid-
ertiary. Stratigraphic relations indicate that
clinal folding (Wasatch and Gates Creek mono-
s) preceded and that high plateau normal fault-
dated the Bullion Canyon lava flows.--Auth.

98. Stanley, D.J. STRATIGRAPHY AND
AMINIFERA OF LOWER TERTIARY VIDOÑO
E, NEAR PUERTO LA CRUZ, VENEZUELA:
Assoc. Petroleum Geologists, Bull., v. 44,
p. 616-627, map, chart, 2 tables, May 1960,
fs.

he mid to upper Vidoño shales in northeastern
zuela contain an abundant foraminiferal fauna.
le 86 species recorded in this paper, 31 are new
formation. A characteristic low-oxygen *Hap-*
agmoides-*Trochammina*-*Cyclammina*-*Glo-*
faunule is restricted to the lower black shales
Vidoño outcrop SW. of Puerto la Cruz. The
ying sediments of this section are different and
in benthonic forms indicating that the density
ified waters of a partly restricted basin were
urned by an incursion of the sea.
he benthonic Foraminifera give the Vidoño shale
upper Cretaceous aspect, but study of the plank-
species, recognized over wider geographical
s, indicates more precise Paleocene (Landenian)
wer Eocene (Ypresian) age for the mid to upper
s and siltstones of the Vidoño formation. Two
s are recognized: a *Globorotalia velascoensis*-
protalia pseudomenardii zone and a younger
protalia rex zone. The Upper Cretaceous to
Eocene planktonic Foraminifera of the Vidoño
s offer a more precise means of studying the
aceous-Tertiary boundary problems in the Car-
on area.--Auth.

99. Gromov, V.I., I.I. Krasnov, and K.V.
rova. MAIN PRINCIPLES OF STRATI-
PHIC DIVISION OF THE QUATERNARY SYSTEM
LOCATION OF ITS LOWER BOUNDARY: Akad.
SSSR, Izvestiya, Geol. Ser., in translation,
no. 5, p. 1-15, 2 tables, pub. March 1960.

he accumulated information from work in recent
s on the stratigraphy, paleontology, and arche-
of the Quaternary indicates the need for a
tion of that system. It is proposed that the
ary be lowered to include a part of the Pliocene,
he name be changed to Anthropogene, and that
divisions be called (from oldest to youngest)
eistocene, Pleistocene, and Holocene.--M.
ell.

100. Gromov, V.I., and E.V. Shantser. THE
GEOLOGIC AGE OF THE PALEOLITHIC IN THE
S.R.: Akad. Nauk SSSR, Izvestiya, Geol. Ser.,
translation, 1958, no. 5, p. 16-24, pub. March
36 refs.

is intended to instigate international reconsider-
of the problem of the age of the Paleolithic,

more specifically to suggest an older age. Archeo-
logic-geologic correlations show early Mousterian
to be pre- or early Riss glacial and late Mousterian
to be Riss maximum. This implies that all earlier
stages of the Paleolithic can be dated as no later than
Mendel-Riss and purely lower Paleolithic as Mendel
or even very earliest Pleistocene.--M. Russell.

2-1701. Hsu, K. Jinghwa. PALEOCURRENT
STRUCTURES AND PALEOGEOGRAPHY OF THE
ULTRAHELNETIC FLYSCH BASINS, SWITZERLAND:
Geol. Soc. America, Bull., v. 71, no. 5, p. 577-
610, 7 maps, 5 secs., 6 diag., 2 tables, May 1960,
84 refs.

The Ultrahelvetetic Flysch of the Swiss Prealps
ranges from Late Cretaceous to Eocene in age. It
occurs as isolated outcrops which are known by var-
ious local names - Wäggital Flysch in the Glarus
Alps, Schlieren Flysch in central Switzerland, Leis-
sigen Flysch in the Internal Prealps SW. of Lake
Thun, and Gurnigel Flysch in the Bernese External
Prealps. These Flysch formations are characterized
by thick sequences of interbedded sandstone, con-
glomerate, shale, and silty limestone. The sand-
stone of the Flysch exhibits sedimentary structures
typical of turbidity-current deposition - e.g., graded
bedding, flute casts, groove casts. About 400
measurements of the directional sedimentary struc-
tures were made from the various Flysch forma-
tions. Paleocurrent information thus obtained was
interpreted within the framework provided by the
stratigraphic and tectonic studies of alpine geologists.
The major conclusions of this paper are:

1) The Ultrahelvetetic Flysch basins of the central
Swiss Alps were created as a result of isostatic ad-
justment subsequent to an episode of pre-Maestrich-
tian folding. During the Maestrichtian to middle
Eocene time, the Ultrahelvetetic region was character-
ized by a topography typical of block-faulted terranes.
Rugged land mass adjoining deep-sea basins resulted
in conditions favorable for periodic turbidity-current
deposition in those basins.

2) The Schlieren Flysch, the Leissigen Flysch,
and the Sandstone Flysch near Adelboden were de-
posited in a row of near-shore deep-sea basins just
S. of a shallow shelf sea where carbonates of the
Helvetic facies accumulated. These Flysch forma-
tions derived their sediments from the S. or SW.
They were subsequently overthrust as the nappes of
the Internal Prealps.

3) The Wäggital Flysch and the Gurnigel Flysch
were deposited in a row of deep-sea basins farther
offshore. These were separated from the nearshore
basins by an island chain which furnished sediments
to both units. Subsequently, the Gurnigel Flysch was
overthrust as a nappe of the External Prealps.--Auth.

2-1702. Faul, Henry. GEOLOGIC TIME SCALE:
Geol. Soc. America, Bull., v. 71, no. 5, p. 637-
644, 2 tables, May 1960, 60 refs.

Evidence is gradually accumulating that the pre-
sently accepted (Holmes-Marble) geologic time
scale should be lengthened, and that this extension
should be greatest in the Paleozoic era. Age deter-
minations on glauconites, however, contradict this
evidence and generally support the present scale.
A review of available data indicates many uncer-
tainties. It still seems doubtful to attempt the con-
struction of a new time scale until the key points can
be established firmly enough to be useful.--th.

2-1703. de Vriès, Hessel, and Aleksis Dreimanis. **FINITE RADIOCARBON DATES OF THE PORT TALBOT INTERSTADIAL DEPOSITS IN SOUTHERN ONTARIO:** *Science*, v. 131, no. 3415, p. 1738-1739, table, June 10, 1960, 9 refs.

Three new finite radiocarbon dates suggest that 1) the thermal maximum of the Port Talbot interstadial occurred prior to 47,000 years before the present, and 2) the interstadial deposits were overridden by a glacial advance approximately 44,000 years before the present. To facilitate correlations with other areas, new rock-stratigraphic names are proposed for the Port Talbot type section.--Auth.

2-1704. Gerling, E.K., and A.A. Polkanov. **THE ABSOLUTE AGE DETERMINATION OF THE PRECAMBRIAN OF THE BALTIC SHIELD:** *Geokhimiya* [in translation], 1958, no. 8, p. 867-896, 2 charts, 6 tables, pub. 1960?, 25 refs.

Data on more than 240 absolute age determinations of micas from Karelia, Kola peninsula, and Finland by means of the K-Ar method, obtained in the Laboratory for Precambrian Geology, Academy of Sciences, U.S.S.R., are given. For the eastern part of the Baltic shield 4 large cycles of sedimentation and metamorphism are marked, having proceeded before the Proterozoic: the Karelian cycle from 1,500 to 1,880 million years; the Belomorian cycle, from 1,830 to 2,000 m. y.; the Saamian cycle, from 2,200 to 2,400 m. y.; the Katarchean cycle, from 2,820 to 3,480 m. y. The organic movements were accompanied by 5 or 6 intrusive cycles of acid magma. The age of the rapakivi granite and the Hoglandian epoch - 1,640 m. y., the age of intrusions of Finland; the post-Karelian (postorogenic 1,650 to 1,750 m. y. and synorogenic 1,760 to 1,860 m. y.); the post-Svonian

(postorogenic 1,550 to 1,660 m. y. and synorogenic 1,760 to 1,860 m. y.); and the age of granite intrusions of the Belomorian complex (1,900 to 2,000 m. y.) are reliable values established by 3 methods (the K-Ar, the Pb, and the Rb-Sr).

The coincidence of age values of post-Karelian and post-Svonian intrusions raises the question about the unity of the period of these intrusions of Finland and the post-Karelian intrusions of Karelia and Kola peninsula.--Auth.

2-1705. Komlev, L.V. **GEOCHRONOLOGICAL SUBDIVISION OF THE PRECAMBRIAN OF THE UKRAINE:** *Geokhimiya* [in translation], 1958, no. 7, p. 782-793, 2 tables, pub. 1960?, 33 refs.

Numerous age data obtained with the aid of Ar and Pb-isotope methods for Precambrian rocks of the Ukraine have been critically examined. A scheme for the geochronological subdivision of the Precambrian of the Ukraine is given, in which 5 magmatic complexes participate. The chief mass of Ukrainian granites has been formed within the narrow time interval of 1,550-2,100 million years, with a sharply marked culmination of magmatism in the interval of 1,900-2,100 million years. The most ancient migmatite and gneiss formations have lasted in the form of separate blocks, for which it is expedient to preserve the name Katarkeia. A progressing geochemical differentiation of magmas with an enrichment in radioactive elements - K, U, and Th - has been established in derivatives of younger cycles. A typical change of accessory minerals from allanite to monazite and thorite is observed. All this bears witness to a definite trend in the geochemical evolution of the crust of the earth in the Ukrainian Precambrian.--Auth.

5. PALEONTOLOGY

See also: Stratigraphy 2-1687, 2-1689, 2-1692, 2-1698; Sedimentary Petrology 2-1778.

2-1706. Darlington, Philip J., Jr. **AREA, CLIMATE AND EVOLUTION:** *Evolution*, v. 13, no. 4, p. 488-510, illus., 8 diag., Dec. 1959, 14 refs.

Based upon zoogeographical considerations, the effects are discussed of the size and climate of an area upon the general adaptation and effective evolution of the fauna, in particular upon mammals. The world-wide distribution and evolutionary history of some dominant groups of mammals are briefly stated: primates, elephants, cattle, horses, and murid rodents. Theories on the influence of area by Darwin and of climate by Matthew are critically reviewed. No supporting evidence is found for the theory formulated by the latter of evolution of dominant animals being induced by a northern cyclical climate. The distribution of living mammals and cold-blooded vertebrates is explained by a new working-hypothesis stressing the great influence of area and a stable, favorable climate upon selection and evolution by adaptation. Under these conditions both area and climate contribute to making the tropics of the Old World (Africa and Eurasia) a unique evolutionary center from which most dominant groups spread northward and subsequently to North and South America, Australia, and island areas. Countermovements also occurred, but on a smaller scale only. Thus the present distribution of mammals is the net result

of an unequal exchange between the regions involved.--C. Voûte.

2-1707. Fischer, Alfred G. **LATITUDINAL VARIATION IN ORGANIC DIVERSITY:** *Evolution*, v. 14, no. 1, p. 64-81, illus., 5 diag., 14 graphs, March 1960, 24 refs.

The diversity of flora and fauna is greatest in climates of relatively high and constant temperature of the tropics and decreases progressively into the fluctuating and cold climates of higher latitudes. In this respect atmospheric weather and climate on land are paralleled by hydrospheric weather and climate in the sea. The differences in climatic gradients along the E. and W. coasts of North America are reflected by similar diversity gradients of the molluscan faunas. This biogeographic pattern is dependent upon the rapidity with which new species evolve under different climates. The evolutionary potential of any species appears to bear little or no relation to climatic conditions. However, selection in the tropics (interorganic struggle for existence) differs from that in high latitudes (random killing by climatic agents). Moreover, the tropical environment is receptive to a wider range of mutations than the temperate and polar environment. The span of time during which the environment continues unaltered determines the maturity of biotic diversity attained at any moment. Marine transgressions, polar wandering,

during some geological periods, oscillations of al polar conditions have profoundly disturbed normal course of evolutionary diversity. The cs have been least affected by climatic fluctua- of the past. Tropical coral reefs and rain t biotas are considered examples of mature ation, whereas the biotas of the regions covered eistocene ice-sheets are relics of mature tem- te Tertiary faunas and floras, which are now in mature stage of a new cycle of evolution.--C. e.

08. Fryer, G. SOME ASPECTS OF EVOLU- IN LAKE NYASA: *Evolution*, v. 13, no. 4, p. 451, illus., 3 diags., Dec. 1959, 26 refs.

theoretical discussion on the origin of many new species in Lake Nyasa, especially among the lidiae. Living conditions in the lake, which sub- during the entire Pleistocene and even during arid interpluvials, are remarkably uniform. The a is mainly found in the pelagic zone and the tically very rich littoral zone, the latter being ived into rocky shores and sandy beaches. use of the size of the lake these zones are frag- ed. Isolation of the ecological niches is achieved both distance and the activity of predators, thus ring the process of speciation. The unusual fact rs that closely related genera and species occupy ame environment and have identical food prefer- s. Annual and longer term lake level fluctua- are suggested as a possible reason for shortage od, causing an intensified competition, elimina- of the less successful individuals or species, migration. Among the plankton-feeding species iving has been extensively adopted. Further ations of evolutionary significance attributed to particular conditions of Lake Nyasa, with its uly populated shores, are prevalence of mouth iding and a general relation between brood size, size, and habitat among the Cichlidae. Thus, ough fresh-water fish in general are apt to sub- under a wide range of conditions and to utilize ous kinds of food, many of the fish in Lake Nyasa extremely specialized.--C. Voûte.

09. Bader, Robert S., and John S. Hall. GEOMETRIC VARIATION AND FUNCTION IN S: *Evolution*, v. 14, no. 1, p. 8-17, illus., 2 graphs, 4 tables, March 1960, 24 refs.

The paper gives the statistical and analytical res- of a total of 26 different measurements carried on the limbs and skulls of 44 mature individuals *Myotis lucifugus lucifugus* Le Conte and *Myotis* lis Miller, collected in the same cave. The ns and coefficients of variation of the skeletal surements are presented in tables and on graphs. appears from this study, which is of interest to the ents of evolution and also of vertebrate paleon- gy, that the general magnitude of variation in ometric characteristics of the bats is intermedi- between the typical values for birds and mam- s. Furthermore the differential pattern of varia- of the skeletal elements measured is associated differences in morphology and function. This ern, including an increase of variation for distal ents of the limbs, is also found with birds but with the terrestrial mammals thus far studied in respect.--C. Voûte.

10. Clark, Wilfrid E. Le Gros. THE NDATIONS OF HUMAN EVOLUTION: 74 p., 8

illus., Eugene, Oregon, Oregon State System of Higher Education, Condon Lectures, 1959, 29 refs.

The anatomical and paleontologic bases for human evolution are reviewed. In developing the lines of evolution probably followed, the relations from the one group to the other are shown of man to the anthro- poid apes, the anthropoid apes to the Catarrhine mon- keys, the Catarrhine to the Platyrrhine monkeys, the tarsoids and Platyrrhine monkeys to the lemurs, and the lemurs to the tree-shrews.

Paleontologically the lineage of human evolution is probably as follows: At the beginning of the Paleo- cene were small tree-shrew-like creatures, the first representatives of the Primate sequence. There was a wide diversification of Primates during the Paleo- cene and Eocene into the 2 main groups of prosimi- ans - lemuroids and tarsoids. By the Oligocene, primitive monkeys, and primitive anthropoid apes with a gibbonlike dentition, had already come into existence, and thereafter adaptive radiations of the higher Primates evidently proceeded rapidly.

During the Miocene, Platyrrhine and Catarrhine monkeys quite similar to Recent genera had become fully established. At the same time the anthropoid ape sequence of evolution was branching out into a great variety of types, large and small, but they were still quite generalized in their morphology. The lower Miocene anthropoid apes of East Africa were anthropoid apes in the making, and from these early types the anthropoid apes of today were initially derived. It is also a reasonable possibility that the Hominidae had their origin in the same, or some closely allied groups, of Miocene apes.

The earliest known fossil record of Hominidae which can be accepted with certainty is *Australopithe- cus*, from the lower Pleistocene of South Africa, and the genera *Australopithecus*-*Pithecanthropus*-*Homo* comprise a morphological sequence which probably also represents a linear sequence of ancestor-de- scendant genera. The earliest known representatives of *Pithecanthropus* date from the middle Pleistocene at least 250,000 years ago, while the earliest known relics of *Homo* are at least 100,000 years old. *Homo sapiens* was in occupation of the Old World 50,000 years ago.--From auth., p. 53-54.

2-1711. Rhoads, Donald C. HYDRODYNAMICS OF THE SHELL AND ORIENTATION AS POSSIBLE CRITERION TO THE ECOLOGY OF NUDIROSTRA ROCKYMONTANUM (MARCOU): *Compass*, v. 37, no. 3, p. 193-197, 6 figs., March 1960, ref.

The streamlined external morphology of *Nudiro- stra rockymontanum* (Marcou) provides a minimum amount of water resistance when the posterior part of the shell is directed toward the current. Turbu- lence created at the anterior commissure in this same position, however, acts as a stabilizer, i.e., it prevents lateral "wobbling" and buoys up the brachi- opod to keep the anterior commissure from becoming fouled by bottom debris. The impossibility of ven- tral attachment of the pedicle due to the aforemen- tioned turbulence is illustrated. A dorsal attachment of the pedicle to rock ledges, reefs, etc. is shown to be the probable orientation of this brachiopod. The ecological implications of this dorsal attachment and the morphology of *Nudirostra rockymontanum* (Marcou) are outlined.--Auth.

2-1712. Foss, Ted H. STRUCTURE AND COM- POSITION OF ASSOCIATED NEURODONTIFORMES AND ASTRASPIS SCALES FROM THE HARDING

FORMATION OF COLORADO: Jour. Paleontology, v. 34, no. 2, p. 372-373, table, March 1960, 3 refs.

Standard X-ray diffraction studies of *Neurodonti-formes* and associated *Astraspis* scales from the Harding formation [Ordovician] show they are both closer in composition to carbonate-fluorapatite than to pure fluorapatite as previously thought.--I.M. Johnston.

2-1713. Adams, John K. NOTE ON LOWER TERTIARY AND UPPER CRETACEOUS OSTRACODA FROM NEW JERSEY: Jour. Paleontology, v. 34, no. 2, p. 371-372, table, March 1960, 2 refs.

Although ostracods are not abundant in the Cretaceous-Tertiary rocks of New Jersey, they are so distinctive that when they are present, they can be used to tell Tertiary rocks from Cretaceous rocks. Two previously undescribed ostracod faunas, one from the Red Bank sand (Monmouth group-Cretaceous) of 26 species and one from the early Tertiary Vincentown sand (Rancocas group - early Tertiary) of 25 sp., are identified.--I.M. Johnston.

2-1714. Grayson, John F. PALYNOLOGY, A WORKING TOOL: Oil & Gas Jour., v. 58, no. 17, p. 136-140, 2 illus., chart, sec., graph, Apr. 25, 1960, 6 refs.

Paly-nology is concerned with the study of pollen and spores. Its potentialities were first recognized by Swedish researchers in postglacial vegetation, stratigraphy, climatology, and paleoecology. The next use was in correlating coal beds in the United States, and paly-nology has finally been adopted by oil companies. The exine of spores and pollen is the part which becomes fossilized, and it is on the basis of differentiation of its morphological detail that identification is made. Polos-pores have an advantage over conventional microfossils in that, being wind-

deposited, they occur in marine, brackish, and continental sediments over very great areas. Paly-nology has been successfully used in correlation work in rocks as old as Paleozoic, and it may be possible to utilize it for intercontinental correlations.--M. Russell.

2-1715. Murray, Grover E., Donald R. Boyd, James A. Wolleben, and John Andrew Wilson. LAT CRETACEOUS FOSSIL LOCALITY, EASTERN PARRAS BASIN, COAHUILA, MEXICO: Jour. Paleontology, v. 34, no. 2, p. 368-370, 2 maps, sec., March 1960, 21 refs.

Stratigraphic studies of the Difunta group (Gulfian Midwayan) have disclosed approximately 11,000 ft. of strata which contain abundant dinosaur and marine molluscan remains in close association at one locality within the Parras basin. This locality is quite inaccessible.

The mollusks (*Ostrea* sp., *Inoceramus* sp., *Sphenodiscus lenticularis*, etc.) occur 50 ft. above the dinosaur horizon (*Monoclonius* sp., etc.) but their stratigraphic position in the lower Difunta is unknown. The fossils indicate Tayloran-Navarroan age for these beds.--I.M. Johnston.

2-1716. Grishkevich, G.N., and L.A. Nevesskaya. FAUNA OF LOWER SARMATIAN CLAY FACIES FROM TRANS-CARPATIA AND KARABUGAZ AREA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 76-79, 2 illus., table, pub. Feb. 1960, 3 refs.

Deposits of the lower Sarmatian stage of the Miocene in Transcarpathia and on the N. shore of the Kara-Bogaz bay of the Caspian, contain a large number of very similar species of fossilized fauna. The authors conclude that both regions were covered in that epoch by the sea, and the evolution of these shells occurred under similar conditions.--LC

6. GEOPHYSICS

See also: Geologic Maps 2-1640 through 2-1649.

2-1717. THE GEOPHYSICAL DIRECTORY: 15th ed., 117 p., Houston, Texas, 1960.

This directory, published annually, is intended to be a comprehensive listing of all companies and individuals directly connected with, or engaged in, the geophysical exploration for petroleum. Information is included on the following: automotive equipment, boats, bulldozer service, core drilling contractors, core hole logging service, drilling bits, drilling rig builders (geophysical), electrical contractors, explosives, geophysical consultants, geophysical education, geophysical instruments, geophysical societies, geophysical supplies - miscellaneous field supplies, gravity meter contractors, helicopters, insurance, magnetometer contractors, marsh buggies, oil companies and individuals who have used geophysics during period 1942-1960 - domestic and foreign, personnel list, photographic supplies, radio and electrical supplies, radioactive surveys, reproduction service, seismograph contractors, shot hole casing, shot hole drilling contractors, soil analysis contractors, surveying crew contractors, torsion balance contractors, and velocity data.

2-1718. U.S. Scientific Laboratory, Los Alamos, New Mexico. THEORY OF GRAVITATION, 1920 TO PRESENT (BIBLIOGRAPHY), compiled by Ruth H. Lier: Its [Rept.] LAMS-2328, 155 p., Apr. 1960.

The bibliography contains 1,030 unannotated references concerned primarily with the theory of relativity, gravitation, gravity, and the unified field theory.

2-1719. Wilson, Raymond H., Jr. A GRAVITATIONAL FORCE FUNCTION FOR THE EARTH REPRESENTING ALL DEVIATIONS FROM A SPHERICAL GEOID: Franklin Inst., Jour., v. 268, no. 5, p. 378-387, 2 diag., Nov. 1959, 14 refs.

In the present treatment each area of deviation from a uniform spherical gravitational field is represented by a separate series of Legendre polynomials having its pole of reference centered on the area. Thus the Earth's N. and S. polar oblateness deviations are represented separately so that their inequality can be investigated. The series for minor deviations centered at general latitudes and longitude has been transformed to terms of variables in the inertial coordinate system for practical computation. The vector sum of these expressions for the Earth's spherical gravitational field and its deviations, to-

er with explicitly presented geocentric expres-
for the fields of the moon and sun, would thus
stitute a complete force function for satellite or-
velopment by numerical integration.--Auth.

20. Nairn, A.E.M. PALEOMAGNETIC
ULTS FROM EUROPE: Jour. Geology, v. 68,
, p. 285-306, 14 maps, 19 diags., 5 tables,
1960, 43 refs.

he results of investigations on a variety of late
zoic and Mesozoic rocks from western Europe
described and are incorporated with results
dy published predominantly from Great Britain.
pole positions have been obtained from the
ssic, Permian, and Devonian periods, for which
ous results are available. The angular dis-
between the mean Triassic pole and a similar
rican pole lends force to the separation of the
ntinents, while the greater separation of Permian
implies that separation commenced in earlier
s. Because of the problems, still unresolved,
e European Carboniferous, this drift history
ot as yet be checked in earlier times.--Auth.

21. Chester, John William. APPLICATION
LECTRICAL-RESISTIVITY SURVEYS TO EX-
RATION FOR ZINC-LEAD DEPOSITS, RACINE-
ERGEON AREA, NEWTON COUNTY, MO.: U.S.
Mines, Rept. Inv. 5503, 57 p., 31 figs. incl.
s, plans, secs., 7 tables, 1959, 16 refs.

uring an investigation of the Racine-Spurgeon
from Dec. 1953 to July 1957, the U.S. Bureau
ines completed 53 mi. of reconnaissance elec-
l-resistivity profiling and 76 test holes aggregat-
3,986 ft. of churn drilling.
he geophysical survey was made under contract
erwin F. Kelly Geophysical Services, Inc. Part
e test drilling was done under contract, and part
accomplished on force account by the Bureau of
es.
lectrical-resistivity measurements disclosed
ge and several smaller low-resistivity anomalies
a few high-resistivity anomalies. Patterns of
high and low readings often vary, but locally the
ds are similar for high and low anomalies.
est drilling shows that most resistivity readings
related to the geology of the area and, in a few
es, to the topography. Low-resistivity areas
related to thickness of overburden, very porous
stone and shale, slumped areas that contain clay
broken chert, and occasionally to swampy areas
e surface. High-resistivity readings are usually
ted to firm, relatively unaltered limestone and
t. The resistivity survey, combined with a study
opographic relationships, indicated favorable
s in which to search for Zn-Pb ore deposits.
est drilling indicated that long, benchlike anom-
s between areas of low- and high-resistivity
ings, such as the one associated with the Win-
ter deposit, are probably the most favorable
s for exploration in this part of the district. The
ern of isoresistivity contour on the Milnot prop-
indicates the presence there of a similar bench-
anomaly. Test drilling disclosed material of
grade on the Milnot property.
est drilling near the Ruark deposit on the Snow
erty indicated a relationship between a saddle-
anomaly and ore deposition.
ocations of sinks or potholes can be determined
relative accuracy by resistivity measurements.
structures are favorable for exploration.

Results indicate that the electrical-resistivity
survey was at least as effective as shale drilling in
delineating favorable areas for exploration. More-
over, the geophysical work was done for about one-
third the cost of obtaining comparable information by
shale drilling.

The holes were drilled primarily to determine
the relationship between resistivity anomalies and
geologic structure, and not to explore for ore depos-
its: 23 of the 76 holes intersected minable thick-
nesses of ore-grade material.

Ore, as used throughout this report, is defined
as material with a minimum grade of 1.5% of Zn with-
in an interval at least 7.5 ft. thick or its equivalent
in feet-percent.--Auth. summ.

2-1722. Tixier, Maurice Pierre, R.P. Alger,
and D.R. Tanguy. NEW DEVELOPMENTS IN IN-
DUCTION AND SONIC LOGGING: Jour. Petroleum
Technology, v. 12, no. 5, p. 79-87, 8 diags., 5
logs, May 1960, 6 refs.

In the combination induction-electrical log used
at present in the field, the induction logging tool is
appropriate for the investigation of moderately in-
vaded formations. A new induction sonde with a
radius and investigation about twice as large has been
developed recently for the case of deep invasion. It
has very nearly the same vertical resolution as the
present sonde so that thin beds are defined as ac-
curately as before. The characteristics of the new
tool are described, the corresponding interpretation
charts are given and field examples are discussed.

The design of the sonic logging tool has been modi-
fied to improve the calibration and the reliability.
The fact that porosity can be accurately recorded by
means of the sonic log has prompted new interpreta-
tion, procedures for saturation estimation, wherein
the data concerning the various permeable beds in a
given well are correlated.

One approach consists of plotting transit time vs.
true resistivity, with an appropriate scale. With
this approach, saturations can be estimated conven-
iently even in cases where formation water resistivity
is not well known.

In another approach, a comparison is made of the
values of the formation waters computed from the re-
sistivity and sonic logs. Using the concept of continu-
ity, this procedure makes possible a quick deter-
mination of zones of saturation in shaly sands and/or
in case of appreciable variations of formation salin-
ities with depth.

It has been found that the comparison of porosity
from the sonic log with the apparent porosity com-
puted from a short-investigation resistivity log may
reveal, in many cases, the presence of residual oil
and thus detect potentially productive formations;
this procedure is valuable when the true formation
resistivity and the resistivity of the formation water
are in doubt.--Auth.

2-1723. Oliver, Jack E., Paul Pomeroy, and
Maurice Ewing. LONG-PERIOD SEISMIC WAVES
FROM NUCLEAR EXPLOSIONS IN VARIOUS ENVI-
RONMENTS: Science, v. 131, no. 3416, p. 1804-
1805, June 17, 1960, 7 refs.

Large nuclear explosions in the solid earth, the
hydrosphere, and the lower and upper atmosphere
have generated seismic waves of periods greater than
about 5 sec. which have been detected at great dis-
tances from the source.--Auth.

2-1724. Roethlisberger, Hans. SEISMIC SURVEY 1957, THULE AREA, GREENLAND: U.S. Snow, Ice & Permafrost Research Establishment, Tech. Rept. 64, 13 p., map, chart, 3 profiles, 3 diags., 2 logs, table, Sept. 1959, 10 refs.

Seismic reflection soundings have been carried out in the vicinity of Camp TUTO, Thule, Greenland, on the edge of the ice cap. Ice thicknesses ranging from 200 to 800 ft. have been determined. With a short shot point to geophone distance only sporadic results could be obtained, while with a long distance, up to 3.5 times the ice thickness, very strong reflection signals were recorded. Evidence was found that some of the reflections did not occur at a single clear interface, indicating the presence of alternate layers of moraine and ice at the bottom of the ice cap. At one location, where the result of the seismic sounding could be compared with drilling results, the error was found to be less than 10 ft., the depth at the place being about 200 ft. Later reflection signals on the seismic records are analyzed by means of a master chart. The usefulness of the refraction method has been established along the ice tunnel.--Auth. summ.

2-1725. Edwards, James M. QUANTITATIVE EVALUATION OF THE DENSITY LOG IN THE ROCKY MOUNTAIN AREA: Jour. Petroleum Technology, v. 11, no. 12, p. 29-34, diag., 3 graphs, 6 logs, table, Dec. 1959, 7 refs.

See also: Stratigraphy 2-1704, 2-1705; Mineralogy 2-1757, 2-1760, 2-1764; Sedimentary Petrology 2-1780, 2-1781; Mineral Deposits 2-1800 through 2-1805.

2-1726. Bisque, Ramon E. WHAT IS A GEOCHEMIST?: GeoTimes, v. 4, no. 7, p. 30, 43-44, Apr. 1960.

A short discussion is given of the problems of interdisciplinary sciences with emphasis on the problems of educating the geochemical graduate student.--R.F. McAllister.

2-1727. Gerasimovsky, V.I. MEETING ON THE 95th ANNIVERSARY OF THE BIRTH OF V.I. VERNADSKII: Geokhimiya [in translation] 1958, no. 3, p. 359-361, pub. 1959.

A brief summary is given of 3 addresses presented at a Jubilee Session of the Vernadsky Memorial Institute of Geochemistry and Analytical Chemistry, Academy of Sciences, U.S.S.R., March 12, 1958.

In "On the Geochemistry of Iron in Sedimentary Rocks," A.B. Ronov reported that the $\text{Fe}_2\text{O}_3/\text{FeO}$ ratio in clays of different ages from the Russian platform increased from older to younger sediments. Ronov suggested that this reflected the increasing intensity of oxidizing processes on the surface of the earth. Peaks of the ratio also coincided with breaks in the evolution of vegetation.

D.P. Malyuga reported on "Biogeochemical Prospecting for Molybdenum." Distribution of Mo in soils and plants provided indications of possible new ore zones at a Cu-Mo deposit in Kadzharan, Armenian S.S.R. The zones were confirmed by drilling.

Yu. A. Surkov gave the paper. "The Alpha Decay of Elements of Intermediate Atomic Weights." Theoretical and experimental studies led to the dis-

The neutron log has been accepted as a standard means of porosity determination for a number of years. The presence of clay or silt in sandstone or carbonate reservoirs has an adverse effect on the quantitative use of the present neutron log. A system responsive to the physical properties of the formation and not to its chemical properties overcomes this limitation. A properly collimated logging tool will accurately measure bulk density of a formation. The intensity of gamma rays (from the source) that have undergone Compton scattering in the formation can be recorded and related to the density of the particular medium. The relation between porosity and density is

$$\phi = \frac{\rho_g - \rho_b}{\rho_g - \rho_f} \times 100$$

where ϕ = porosity in percent,

ρ_g = grain density in gm./cc.,

ρ_b = bulk density in gm./cc.,

ρ_f = density of fluid in the pore spaces in gm./cc.

Grain densities of major minerals are known. Fluid density can be considered unity unless gas is the saturating medium. Bulk density from the density log completes the solution of the equation and provides the formation porosity. Success has been obtained with the density log in the Paradox, San Juan, and Green River basins of the Rocky Mountain area.--Auth.

7. GEOCHEMISTRY

covery of some new alpha-active isotopes of intermediate atomic weight.--F. Manheim.

2-1728. Stevens, Rollin E., Sarah T. Neil, and Charles E. Roberson, comps. GRAVIMETRIC CONVERSION FACTORS: Am. Geol. Inst., AGI Data Sheet 18a, 2 p., in GeoTimes, v. 4, no. 7, p. 41-42, Apr. 1960; AGI Data Sheet 18b, 2 p., in GeoTimes, v. 4, no. 8, p. 23-24, May-June 1960, 4 refs.

This data sheet, in 2 parts, gives gravimetric conversion factors and other data used in interpreting analyses of rocks, minerals, and waters. Equivalent weights, gravimetric factors, and significant figures are defined and some uses given in the first part. Also included in Data Sheet 18a is an alphabetical listing of constituents from Ag through FeO for which the following information is given: formula or atomic weight, weight of one equivalent, constituent sought, and gravimetric factor. The list is completed in Data Sheet 18b which covers Mn through ZrO_2 .

2-1729. Weeks, Lewis G. RESEARCH IN ORGANIC GEOCHEMISTRY: Am. Assoc. Petroleum Geologists Bull., v. 44, no. 4, p. 499-500, Apr. 1960.

To promote closer scientific liaison between petroleum geologists and organic chemists, an Organic Geochemistry Group was formed at the 1959 Geological Society of America meeting in Pittsburgh. The purpose of this group is to encourage and foster studies in the origin, nature, and diagenesis of organic substances as related to their geological occurrence and history.--I.M. Johnston.

2-1730. Crawford, T.C., and John E. Allen. A FUSION METHOD FOR QUICK DETERMINATION OF

MAIN RARE METALS: Jour. Geol. Education, v. 1, p. 11-13, chart, Spring 1960.

minute amounts of the elements Cr, Co, Nb, Mn, Ti, W, U, and V can be quickly and easily determined with a minimum of equipment by means of the fusion with ammonium hypophosphite.--Auth.

31. Alexandrov, I.V. D.S. KORZHINSKII'S CONCLUSIONS CONCERNING THE PHASE RULE: *Geokhimiya* [in translation] 1958, no. 3, p. 353-358, 1959, 4 refs.

Korzhinsky's proposed equations for the Phase Rule in open systems with entirely mobile components are criticized. The author reviews Korzhinsky's derivation of the Phase Rule in light of the commonly cited Gibbs formulation, $n = k + 2 - z$, and finds Korzhinsky's proposed supplements do not constitute an improvement.--F. Manheim.

32. Khitarov, N.I., and S.D. Malinin. PHASE EQUILIBRIA IN THE SYSTEM H_2O-CO_2 : *Geokhimiya* [translation], 1958, no. 7, p. 846-848, diag., 1960?, 4 refs.

The phase relations in the system H_2O-CO_2 up to a temperature of 330° and a pressure of 600 kg./cm.² have been studied. The presence of critical transition of the system has been established. The presence of CO_2 lowers the critical temperatures. On the basis of the diagram, H_2O-CO_2 considerations concerning the behavior of hydrothermal waters under geoseated conditions are stated.--Auth.

33. Goldsmith, Julian R., and Donald L. Graf. SOLIDUS RELATIONS IN THE SYSTEM $CaO_3-MgCO_3-MnCO_3$: Jour. Geology, v. 68, no. 3, 24-335, 8 diags., 3 tables, May 1960, 10 refs.

The system $CaCO_3-MgCO_3-MnCO_3$ was investigated at temperatures of 500° , 600° , 700° , and $800^\circ C.$ and 10 kilobars total pressure. Three 2-phase areas and one 3-phase triangle are observed, and an additional 2-phase area is inferred. At $800^\circ C.$ there are 2 single-phase regions, which enclose and merge at higher temperatures. At $800^\circ C.$ the 3-phase triangle and its adjacent Mn-rich 2-phase region occupy only a very limited portion of the diagram, and the principal 2-phase regions extend into the system from the $CaCO_3-MgCO_3$ binary immiscibility gaps. At 500° and $600^\circ C.$ the $CaMg(CO_3)_2-CaMn(CO_3)_2$ is encroached upon by the 2-phase region extending from the Ca-rich portion of the system, but at higher temperatures a single-phase region extends along the join, which becomes binary in nature. The formation of compounds having dolomite-type structures, which occurs along part of this join and adjacent regions of the ternary system, depends on temperature as well as upon relative proportions of the 3 cations.--Auth.

34. Urey, Harold C. ON THE CHEMICAL COMPOSITION AND DENSITIES OF THE PLANETS: *Geochim. et Cosmochim. Acta*, v. 18, no. 1/2, p. 153, Jan. 1960, 7 refs.

The author criticizes Ringwood's recent explanation for the variable densities of the terrestrial planets [GeoScience Abstracts 1-1208]. Ringwood's thesis of reduction of SiO_2 and iron oxides by C is found to be subject to a number of unresolvable difficulties. Among these are cited the loss of the

high atomic weight gases, the lack of a suitable mechanism to explain the loss of the large amounts of C required by Ringwood's theory, the low density of the moon, and the insupportability of the meteorite planet postulated by Ringwood to explain meteorite structures.

The author prefers a theory of early fractionation and separation of silicate and metal phases, a suggestion which is supported by recent cosmic ray ages for stone and Fe meteorites. These data indicate that the silicate and metal phases represented by above objects have become separated from each other.

In conclusion, present meteoric abundance data should not be taken as more than an approximation to the true values.--F. Manheim.

2-1735. Paneth, F.A. THE DISCOVERY AND EARLIEST REPRODUCTIONS OF THE WIDMANSTÄTTEN FIGURES: *Geochim. et Cosmochim. Acta*, v. 18, no. 3/4, p. 176-182, 5 illus., Feb. 1960, 16 refs.

The Widmanstätten structures in meteorites were discovered independently by Alois von Widmanstätten and the little-known G. Thomson (first name unknown), an Englishman living in Naples. Thomson's discovery was published in 1808 and his careful observations were the more remarkable because of the adverse conditions under which his studies were made.

A number of different methods which have been used for the reproduction of the Widmanstätten figures are described, beginning with the "Natur-selbstdruck" of Widmanstätten and the hand drawing of Thomson to the present.--F. Manheim.

2-1736. Tovarova, I.I. REMOVAL OF WATER-SOLUBLE SUBSTANCES FROM THE PYROCLASTIC ROCKS OF THE VOLCANO BEZMYANNI: *Geokhimiya* [in translation], 1958, no. 7, p. 856-860, 3 tables, pub. 1960?, 2 refs.

The 1955-1956 eruptions of the Bezmyannaya volcano, Kamchatka peninsula resulted in expulsion of 0.9×10^9 tons or a cu. km. of ash; the weight of the agglomerate ejected was estimated at 3.3×10^9 tons. On the basis of analytical data, the eruption brought to the surface about 20 million tons of easily soluble material. Water samples (of pH6) collected from hot springs of $65^\circ C.$ are highly mineralized being enriched in sulfate and Cl ions, CO_2 , and Ca. Comparison of artificial leaches of the Kamchatka volcano agglomerate prepared at room temperature show less mineralization than natural surface material, probably because of lower temperature and smaller volume of leach matrix present in the artificial system.--Auth.

2-1737. Tauson, L.V. EFFECT OF MINERAL STRUCTURE ON THE ISOMORPHOUS REPLACEMENTS IN SILICATES OF EFFUSIVE ROCKS: *Geokhimiya* [in translation], 1958, no. 8, p. 917-925, 2 tables, pub. 1960?, 6 refs.

The influence of the structure of crystalline silicate lattices upon the distribution of rare elements in minerals of igneous rocks is shown in a number of examples. The predominant Rb concentration in biotite and the proportional distribution of Ba and Pb among the biotite and the K feldspar of the rocks is established and brought into connection with the peculiarities of the structural position of K and Al in

the lattices of these minerals.

In the case of Li and Ge, the assumption is expressed that the influence of the structures of minerals upon isomorphous replacements in silicates affects the geochemical history of these elements in the magmatic process.--Auth.

2-1738. Solodov, N.A. DISTRIBUTION OF RARE ELEMENTS IN MINERALS OF RARE-METAL GRANITE PEGMATITES: *Geokhimiya* [in translation], 1958, no. 8, p. 932-940, 6 tables, pub. 1960?, 5 refs.

The contents of Li, Rb, Cs, Be, Ta, and Nb in minerals of rare-metal granite pegmatites have been studied. The average content of Ta and Nb in these minerals (from veins rich in rare elements) does not exceed 0.0003%; Li, 0.018%; Cs, 0.107%; and the Rb content reaches 0.64%. The dispersion of rare elements is chiefly determined by 4 factors: 1) the crystal-chemical properties of the rare elements, 2) their concentration, 3) the chemical character of the medium, and 4) the presence of favorable crystal structures in the form of such minerals as mica, tourmaline, beryl, among others.--Auth.

2-1739. Brown, P.E., and B.J. Rushton. SOME CHEMICAL DATA ON THE MOURNE MOUNTAIN GRANITE G2: *Geochim. et Cosmochim. Acta*, v. 18, no. 3/4, p. 193-199, map, 3 tables, Feb. 1960, 14 refs.

New analyses of 17 samples of the Mourne Mountain granite, G2, are presented. Ti, Al, total Fe, Mn, Mg, Ca, Na and K were determined spectrochemically, and the precision and accuracy of the analytical methods are discussed.

The results indicate essential uniformity for the granite mass, with the largest variation shown by the alkalis. The granites are somewhat unusual because of their high silica, low Ca and very low Mg contents. Sharp contacts, chilled zones, veining, and other data lead the authors to conclude that the granite was emplaced by a rapidly cooling, volatile-rich magma. The ultimate origin of the magma is ascribed to the refusion and mobilization of parts of a much larger basic rock mass underlying the region.--F. Manheim.

2-1740. Sindeeva, N.D. SELENIUM AND TELLURIUM IN DEPOSITS OF DIFFERENT GENETIC TYPE: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1958, no. 5, p. 74-87, table, pub. March 1960, 12 refs.

One of the main geochemical properties of Se and Te is their ambivalent character. Because of this ambivalence a considerable quantity of Se is dispersed in deposits of its chemical analogue, S, because it is close in chemical properties. In other cases, Se, [and] particularly Te, due to the differences between their properties and those of S, become fixed in the form of independent minerals under certain conditions. In this way considerable accumulations are formed.

Because the extraction of Se and Te as by-products from Cu and pyrite deposits has satisfied the needs of industry up to now, the study of different genetic-type deposits practically has not been carried out. The first attempt to classify genetic types of deposits containing Se and Te and to give their geologic characteristics and industrial evaluation has been done in this work.

These deposits can be formed by different endo-

genic processes. The largest reserves of Se are related to certain magmatic deposits. The largest reserves of Te together with Se are associated with postmagmatic deposits containing pyrite and Cu-bearing Mo. Several other postmagmatic ore bodies also have Te and Se and potentially can be the source of these elements. Here we must mention the series of Pb-Zn, cassiterite-quartz-sulfide, cobaltite-selenide-telluride, arsenopyrite, Au ore, and other deposits. The formation of Se deposits in association with U is related to exogenic processes. Industrial deposits of Te of analogous character are not known.

In sulfide deposits, the highest Se content is usually held by chalcopyrite and the lowest by sphalerite, but together with chalcopyrite a similar and sometimes high content characterizes pyrite and molybdenite. The latest stages in the process of mineralization developed the highest concentration. Te also has a higher concentration in the same minerals and in the same stages. In Pb-Zn deposits Te is concentrated chiefly in galena.

The largest number of Se- and Te-bearing deposits are related to acid or moderately acid granitoids, but the largest reserves of this element occur chiefly in basic intrusives. Deposits related to alkalic rocks are of minor importance.--Auth. concl.

2-1741. Vishnevsky, A.S. NEW DATA ON THE DISTRIBUTION OF INDIUM IN MINERALS OF THE OXIDIZED ZONE: *Geokhimiya* [in translation], 1958, no. 7, p. 851-855, 2 tables, pub. 1960?, 3 refs.

New data on the chemistry of In in the oxidized zone of the Sn-Pb-Zn deposit of Sarybulak (central Tien-Shan) have been obtained. The results of the chemical analysis of 32 samples of minerals and their mixtures enable us to draw the following conclusions: High In concentrations are observed in the oxidation zone. Hypogene ores composed of sulfides of Sn, Cu, Zn, Pb, Sb, Fe, and cassiterite were the source of In. Ferric hydroxides, hydrocassiterite, and bindheimite are the mineral concentrators of In in the supergene zone. The concentration of In probably may be explained by the high absorptive properties of the gels of Fe, Sn hydroxides and of the complex gel of bindheimite composition, in conjunction with the easy polarizability of the In compounds.--Auth.

2-1742. Leonova, L.L., and L.V. Tauson. THE DISTRIBUTION OF URANIUM IN THE MINERALS OF CALEDONIAN GRANITOIDS OF THE SUSAMYR BATHOLITH (CENTRAL TIEN SHAN): *Geokhimiya* [in translation], 1958, no. 7, p. 815-826, 4 illus., 3 tables, pub. 1960?, 12 refs.

It has been established that U is present in all the minerals of the rocks but in different amounts. 40-50% of the U of the rock is usually found in rock-forming minerals and 50-60% in accessory minerals.

Microradiographic analysis and leaching of U from rocks show that U is present in 2 forms: 1) as an isomorphous constituent in accessory minerals (zircon, sphene, allanite), 2) as nonisomorphous, molecularly disseminated U in rock-forming minerals and microscopic and submicroscopic isolations of U minerals. Among the accessory minerals a specific U concentrator typifies each of the intrusive phases.--Auth.

2-1743. Kemp, D.M., and A.A. Smales. NEUTRON ACTIVATION RESULTS FOR VANADIUM AND SCANDIUM IN G-1 AND W-1: *Geochim. et Cosmo-*

chim. Acta, v. 18, no. 1/2, p. 149-150, table, Jan. 1960, 5 refs.

V and Sc concentrations were determined for the international rock standards, G-1 and W-1, as follows (average values in p.p.m.):

	G-1	W-1
V	13	246
Sc	2.8	34

The results generally reinforce previously recommended values for Sc in both G-1 and W-1 and for V in W-1, while V in G-1 is found to be lower than previously recommended values.--F. Manheim.

2-1744. Gerasimovsky, V.I., A.M. Tuzova, and I.D. Shevaleevsky. THE ZIRCONIUM-HAFNIUM (CELTUM) RATIO IN THE LOVOZERO MASSIF ROCKS: *Geokhimiya* [in translation], 1958, no. 8, p. 926-931, graph, 2 tables, pub. 1960?, 11 refs.

The Zr and Hf content in rocks of the Lovozero massif (Kola peninsula) varies in wide ranges from 0.071 to 2.31% ZrO_2 and from 0.015 to 0.057% HfO_2 , whereas the ZrO_2/HfO_2 ratio varies insignificantly from 32 to 54. The Zr content in the miaskite rocks of the massif (0.167% ZrO_2) is lower than in the apaitic rocks (0.290% and 1.49%). In apaitic rocks, no direct interdependence exists between the Na and K content on one hand and the Zr and Hf content on the other hand. At the end of the magmatic process an accumulation of Zr and Hf occurs.--Auth.

2-1745. Alekseev, F.A., V.I. Ermakov, and V.A. Filonov. RADIOACTIVE ELEMENTS IN OIL FIELD WATERS: *Geokhimiya* [in translation], 1958, no. 7, p. 806-814, 8 tables, pub. 1960?, 12 refs.

New data on the content and distribution of U and Ra in the waters of oil fields of the platform and the folded area, as well as of beds related to reef and salt dome structures, have been considered. For all types of fields similar Ra concentrations ($n \times 10^{-10}$ g./l.) and a low U content, rarely exceeding 1.0×10^{-7} g./l., have been noted. A decrease of the Ra content in the upper water-bearing horizons with a relative U increase has been observed. These peculiarities in the Ra and U contents in waters of oil fields are due to the specific geochemical conditions typical to oil fields.--Auth.

2-1746. Baas Becking, L. G. M., I.R. Kaplan, and D. Moore. LIMITS OF THE NATURAL ENVIRONMENT IN TERMS OF pH AND OXIDATION-REDUCTION POTENTIALS: *Jour. Geology*, v. 68, no. 3, p. 243-284, chart, 35 diags., 2 tables, May 1960, 97 refs.

1) The electron and the proton content (measured as electrode potential [Eh] and pH) of an environment characterize this environment in many ways. In this paper the electrode potential and the pH are used as empirical parameters rather than as electrochemical data capable of thermodynamic interpretation. From published and unpublished work by the authors and from the literature, more than 6,200 pairs of characteristics were gathered, covering most types of the aqueous environment as well as the potential milieu of the chief actors in these environments: algae and bacteria.

2) It appears that the Eh-pH limits of biological systems and of the naturally occurring aqueous environment almost coincide. This would indicate that there are few, if any, sterile terrestrial environ-

ments caused by limiting Eh-pH characteristics.

3) As it seems unlikely that environments will be found outside the limits outlined in this paper, physicochemical speculations on the sedimentary environment should be limited by this outline. Substances which do not occur (sulfuric acid, sulfide ion) should not be used in the electrochemical characterization of the environment.

4) The biogenic master reaction in the environment, changing one or both characteristics (Eh-pH), is reductive photosynthesis by algae and by colored bacteria. A photosynthetic mass may raise the pH of a water to 9.4; and in the absence of bivalent cations, to 12.6.

5) The intensity of sulfate reduction depends upon the sulfate content of the water and on the available H, in both organic and inorganic form. The Fe concentration is also important, as Fe is the principal acceptor of the H_2S formed. The highly reactive, black iron sulfides may be partly oxidized with the formation of the more stable pyrite and marcasite. The reduction of Fe from ferric to ferrous state takes place even in surface soil.

6) Denitrification, another biologically important reduction, may be of lesser geochemical influence.

7) Oxidative reactions comprise, apart from nitrification, chiefly the oxidation of H_2S and SH^- to S, thiosulfate, sulfite, hydrosulfite, sulfate, and hydrosulfate and the oxidation of ferrous and manganous compounds. In contrast with the reductions, these oxidations are only in part biological. The oxidation of pyrite may give rise to extremely low pH values. Heterotrophic oxidation (respiration) results in the conversion of organic matter into CO_2 and H_2O .

8) Acid formation in peat bogs is caused largely by cation exchange on plant cell walls, chiefly, but not exclusively, on *Sphagnum*.

9) In sediments the reaction between iron phosphate complexes and H_2S may liberate the acid $H_2PO_4^-$ ion.

10) Certain environments are restricted, others cover almost the maximal area outlined in this paper. A progressive increase in the environmental range, arranged in a series, follows: rain water, mine water, peat bogs, sea water, rivers and lakes, marine sediments, and evaporites, while the geochemical environment shows the maximal area.

11) The potential milieu of the green bacteria is highly restricted. Less restricted is the environment of the Fe bacteria, followed by sulfate-reducing bacteria, purple bacteria, and denitrifying bacteria. Thiobacteria have a very wide potential milieu, and algae are found literally everywhere.

12) The Eh-pH characteristics are determined chiefly by photosynthesis, by respiration, and by oxido-reductive changes in the Fe and S systems.--Auth.

2-1747. Vinogradov, A.P., E.I. Dontsova, and M.S. Chupakhin. ISOTOPIC RATIOS OF OXYGEN IN METEORITES AND IGNEOUS ROCKS: *Geochim. et Cosmochim. Acta*, v. 18, no. 3/4, p. 278-293, 5 diags., 7 tables, Feb. 1960, 15 refs.

Over 100 determinations of the isotopic composition of O were made on meteorites and igneous rocks. O was extracted from the analysis material by high-temperature reduction with graphite, and the determinations were made on CO_2 and CO using a double-collector mass spectrometer.

The results showed that the isotopic composition of O in the silicate phase of pallasites and chondrites

is identical, with a mean O^{16}/O^{18} ratio of 490.3-490.4. Achondrites show slightly lower ratios, 490.1, while carbonaceous meteorites showed a mean ratio of 488.9.

Ultrabasic rocks were found to have nearly identical ratios to those in pallasites, while basic rocks and granites showed progressively increasing O^{18} content. The highest O^{18} content is found in quartz, with a ratio of 487+1.

The conclusion is drawn that processes that develop in the earth's crust and lead to lower O^{16}/O^{18} ratios did not occur in the formation of meteorites, and that the latter are genetically more akin to dunites.--F. Mannheim.

2-1748. Kashkarov, L. L., and V. V. Cherdyn'tsev. NEUTRON EMISSION FROM MINERALS AND THE ORIGIN OF Ne^{21} IN THE EARTH'S ATMOSPHERE: *Geokhimiya* [in translation], 1958, no. 7, p. 794-805, 2 diags., graph, 3 tables, pub. 1960?, 12 refs.

The neutron radiation of radioactive minerals has been examined. For ferritorites the average neutron yield is 0.9 ± 0.2 neutrons per 10^6 α -particles, and for U minerals 0.39 ± 0.03 neutrons per 10^6 α -particles. It has been shown that about 40% of neutrons in the radiation of U minerals are neutrons of a spontaneous fission.

The chief reaction of the artificial transformation leading to neutron formation is the $O^{18}(\alpha n)Ne^{21}$ reaction. The neutron yield at the expense of it is about 0.2 per 10^6 of α -particles both for the Th and the U family. It has been shown that no less than a quarter of Ne^{21} of the earth atmosphere is connected with the formation of this isotope at the expense of the (αn) reaction in the earth's crust.--Auth.

2-1749. Naydenov, B. M., and V. V. Cherdyn'tsev. CHANGE IN THE ISOTOPE COMPOSITION OF LEAD DURING SEPARATION FROM NATURAL MINERALS: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1958, no. 5, p. 39-47, 2 graphs, 4 tables, pub. March 1960, 9 refs.

The possibility of change in the ratio of radioactive and stable isotopes of Pb during the transition from the solid phase in natural minerals to dissolved phase in solution is the topic of this article. The ratio of individual isotopes is apt to change as much as 10 times. The change in the isotopic content of Pb during its separation from minerals should be accounted for during the study of the behavior of Pb in geologic processes.--Auth.

2-1750. Petrovskaya, N. V., L. N. Grinenko, and M. S. Chupakhin. APPLICATION OF SULFUR ISOTOPE ANALYSIS IN THE STUDY OF THE UCHALA (SOUTH URALS) COPPER PYRITES: *Geokhimiya* [in translation], 1958, no. 8, p. 907-916, pub. 1960?, 12 refs.

S isotope analysis has been used for ascertaining the genesis of minerals of the Cu-pyrite Uchala deposit in the southern Urals. The data indicate that the pyrite ores and the Cu-Zn ores belong to different stages of ore formation. The similarity of the isotopic S composition of pyrite of massive and impregnated ores bears witness to a common S source for the solutions which formed them.--Auth.

2-1751. Rubinshteyn, M. M. BRIEF COMMUNICATIONS ON THE METHOD OF OBTAINING MONOMINERAL FRACTIONS FOR DETERMINING THE AB-

SOLUTE AGE OF ROCKS BY THE ARGON METHOD: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1958, no. 6, p. 79-83, 2 illus., 2 diags., pub. Apr. 1960, 6 refs.

English translation of GeoScience Abstracts 1-186.

2-1752. Gerling, E. K., and I. M. Morozova. THE KINETICS OF ARGON LIBERATION FROM MICROCLINE-PERTHITE: *Geokhimiya* [in translation], 1958, no. 7, p. 775-781, 8 graphs, table, pub. 1960?, 12 refs.

The investigation was carried out over the temperature interval of 500° to 100° with the aid of a mass spectrometer. For the microcline-perthite used, 5 Ar positions were ascertained, the isolations from which are connected with various values of the activation energy.

The activation energies of 15,000, 26,000 and 42,000 cal./g.-atom of Ar characterize the Ar diffusion according to the disturbances of the crystal. Values of the activation energies of 99,000 and 130,000 cal./g.-atom of Ar are connected with a shift of Ar in the undisturbed lattice of the mineral. It has been shown with the aid of calculations that the Ar amount in the first 3 positions of microcline-perthite equals 20% of the total content. A part of the easily isolated Ar may be lost by the mineral, and therefore microcline is essentially unsuitable for age determination by the Ar method.--Auth.

2-1753. Polevaya, N. I., N. E. Titov, V. S. Belyaev, and V. D. Sprintsson. APPLICATION OF THE Ca METHOD IN THE ABSOLUTE AGE DETERMINATION OF SYLVITES: *Geokhimiya* [in translation], 1958, no. 8, p. 897-906, 2 diags., 6 tables, pub. 1960?, 14 refs.

Parallel determinations of sylvite age with the aid of the Ca and K-Ar methods have been carried out. Radiogenic Ca was determined using the method of isotopic dilution, and the K content in sylvites was determined using the dipycrilamine method. Ar was isolated from the samples by melting sylvite in vacuum and was measured using the volumetric method. The results obtained show good preservation of radiogenic Ar in samples not having been submitted to recrystallization. The age data for sylvites not recrystallized agree well according to the independent Ar^{40}/K^{40} and Ca^{40}/K^{40} ratios. The experiments have shown that the recrystallization of sylvite does not influence the data of the Ca method. The lesser migration capacity of Ca compared to Ar makes it possible to determine the age of K salts with the aid of the Ca method even in the case of their complete recrystallization.--Auth.

2-1754. Kalyuzhny, V. A. LIQUID INCLUSIONS IN MINERALS AS A GEOLOGIC BAROMETER. Translated by V. P. Sokoloff: *Internat. Geology Rev.*, v. 2, no. 3, p. 181-195, 12 illus., 5 diags., 3 tables, March 1960, 15 refs.

The understanding and determination of pressures at the time of mineral formation is an important factor in the study of mineral-forming environments; environmental pressures are derived through investigation of physicochemical properties of gaseous-liquid inclusions. The pressure-temperature (P-T) diagram for H_2O with specific-volume isograds is used as a basis of computation.

Complex CO_2 -inclusion samples for experimentation were taken from quartz crystals found in the

Nogolny range (Donbass). A basic premise of pressure estimation involved ascertaining that conditions were identical for capture of both CO_2 and H_2O phases by minerals from a system in its heterogeneous state. The capture process may have involved adhesion of CO_2 bubbles to crystal faces as carbonic acid moved (as an emulsion) with the mother liquors.

Two types of syngenetic inclusion are investigated: 1) homogeneous inclusions consisting of aqueous, or gaseous, solution of "pure" carbonic acid were used for temperature determinations; 2) [heterogeneous] inclusions were used for pressure determinations. The latter required estimation of specific weight (specific volume) for inclusion contents at the time of inclusion sealing. Complex relationships of included matter with respect to liquid and gaseous phase-volume ratios to aqueous-solution content and to solubility of carbonic acid in water and of H_2O in CO_2 necessitated careful compensation for error throughout the investigation. Inclusion cavity vol-

umes were expressed as 2 hexagonal pyramids plus one prism, and liquid carbonic-acid and gas-bubble inclusion volumes, as spheres standard for the computation of actual volumes for deformed gas bubbles.

The author describes a method and apparatus for measurement of gaseous-bubble volumes and for transfer of included materials to determine deformation effects on gaseous-liquid inclusion volumes. Dimensions of gaseous bubbles are compared to those of ideal geometric figures. It was found that gaseous bubbles up to 0.4 mm. in diameter were not deformed, i.e. spherical, and those 0.4 to 2.0 mm. in diameter approached the shape of an ellipsoid of rotation; in this case, 10% reduction in volume was introduced as compensation for error.

Pressure calculated for Volynian pegmatites at the time of crack healing in morion was based on 2, largely gaseous, inclusions. Pressures established for the time of mineral formation were a minimum of 222 atm. for the first sample, and 292 atm. for the second.--D. D. Fisher.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geomorphology 2-1673, 2-1674; Geochemistry 2-1737; Mineral Deposits 2-1810, 2-1822.

2-1755. Travis, Russell B. ISOGYROMETER: A DEVICE FOR ILLUSTRATING ISOGYRE THEORY: Jour. Geol. Education, v. 7, no. 2, p. 54-60, illus., 13 diags., Fall 1959, 2 refs.

By means of a relatively simple mechanical device, called an isogyrometer, it is possible to show students of optical mineralogy why isogyres exist, why they behave as they do, and how the positions of the optic elements can be determined from interference figures. The isogyrometer consists of a box-frame supporting a rotatable sphere that can be viewed through a circular window representing the microscope field. Lines of equal velocity (isotaques) are drawn on the sphere, and lines representing the vibration directions of the crossed polarizers in a microscope are drawn on the window. Where the isotaques and the lines on the window are parallel, light would be extinguished under the microscope, producing isogyres. The device includes 4 interchangeable spheres, one to represent uniaxial minerals and the others to represent biaxial minerals with optic angles of 30° , 60° , and 90° . Construction of the isogyrometer is explained, and its uses and limitations are discussed.--Auth.

2-1756. Azároff, Leonid V. INTRODUCTION TO SOLIDS: 460 p., illus., diags., graphs, tables, New York, McGraw-Hill Book Company, 1960, refs.

This book attempts to provide a broad background on the structure, nature, and properties of inorganic crystalline solids on a sufficiently elementary level to be useful to students of chemistry, ceramics, metallurgy, mineralogy, physics, and engineering fields. The crystallinity of solids is used as a framework in discussing their nature and properties. The text begins with a discussion of elementary crystallography and deals with formation, growth, and deformation of crystals, their interaction with each other, the forms in which they exist. Principles of quantum mechanics are then considered and the results applied to metals, semiconductors, and insulators. Mathematical complexity is kept at a minimum.

Structure of crystals
Atomic packings in crystals
Imperfections in atomic packings
Mechanical properties of crystals
Formation of crystals
Transformations in crystals
Bonding of atoms
Properties of metals
Structure of metals
Properties of semiconductors
Structure of semiconductors
Properties of insulators
Structure of insulators.

Appendices:
Physical constants
Conversion units
Atomic radii
Space-group symbols

2-1757. Barsukov, V. L. BORON ISOMORPHISM IN SILICATES: Geokhimiya [in translation], 1958, no. 7, p. 827-834, 3 tables, pub. 1960?, 13 refs.

A different character of interdependence of B and Al isomorphism with Si in silicates belonging to different structural groups has been established. Some kinds of B isomorphism in silicates are considered. Each of them is typical for a definite group. It has been shown that the B isomorphism may occur only in orthosilicates, metasilicates with a chain radical, and in some frame silicates, whereas in most framework silicates as well as in double chain and sheet silicates this isomorphism is scarcely probable. After having analyzed the possibilities for the isomorphism in various rock-forming minerals of intrusive rocks, the conclusion is drawn that the B content of these rocks is connected with an increased B concentration in plagioclases.--Auth.

2-1758. Cherkasov, Yu. A. APPLICATION OF 'FOCAL SCREENING' TO MEASUREMENT OF INDICES OF REFRACTION BY THE IMMERSION METHOD. Translated by Ivan Mittin: Internat. Geology Rev., v. 2, no. 3, p. 218-235, illus., 11 diags., 3 tables, March 1960, 14 refs.

A parallel ray-bundle of white light, crossing the

solid/liquid boundary at a small angle, is spread into a spectrum when the index of the immersion liquid approaches that of the solid. This is due to the greater dispersion of liquids and forms the basis of the 3 variants of the "focal screening" method, using appropriate masks in the focal plane of the objective: 1) In apertural screening the ray-bundle is parallel to the microscope axis, and an iris diaphragm in the focal plane of the objective is restricted until only the undeviated wavelengths pass. Thus at the grain edges only the color for which the index of liquid and solid match is seen. 2) In unilateral screening the ray-bundle is inclined, and the diaphragm is restricted to block certain of the rays and reveal different colors on opposite edges of the grain. 3) In central screening the ray-bundle is again parallel to the microscope axis, and a dot mask at the center of the focal plane holds back the undeviated rays. The edge color is a recognizable combination of those of the deviated rays.

Indices are said to be measurable to .001 with the first arrangement, more accurately with the second, and "more accurately than by the Becke method" with the third. Advantages include the benefits of chromatic variation without requiring a variable monochromator, visibility of grains at the match point, and less disturbance by inclusions. The effectiveness of this method is increased by quantitative data on the dispersion of the liquids.--R. E. Wilcox.

2-1759. Eppelsheimer, Daniel S., and L. J. Reitsma, Jr. STRESS-RUPTURE PROPERTIES OF INDIUM: *Compass*, v. 37, no. 3, p. 187-192, 3 illus., 4 graphs, table, March 1960, 4 refs.

Stress-rupture data for In were obtained. Plots of stress versus time to rupture, stress versus log time to rupture were made. A master rupture curve for In was also plotted.--Auth.

2-1760. Nesterova, Yu. S. THE CHEMICAL COMPOSITION OF GALENA: *Geokhimiya* [in translation], 1958, no. 7, p. 835-845, 5 tables, pub. 1960?, 2 refs.

Forty chemical analyses of galena from various areas of the U. S. S. R. (24 by the author) have been recalculated for mineral admixtures. It has been found that of the primary minerals, the following occur especially commonly as admixtures in the galena under examination: argentite, boulangerite, sphalerite, chalcopryrite, bismuthinite, lyrite; of the secondary, cerussite, covellite, and anglesite are most frequently encountered. The rather common admixture of native S requires a special investigation and is a problem for further study.

The data obtained allow comparison of galena from these areas of the U. S. S. R. according to character and amount of inclusions of Ag, Sb, Bi, and Sn minerals. The author concludes that the elements commonly occurring in galena - Ag, Bi, As, Sb, Sn, Cu, and Fe - do not enter the galena lattice but belong to independent minerals, a very fine admixture of which commonly may not be detected under the microscope.--Auth.

2-1761. Kuellmer, Frederick J. X-RAY INTENSITY MEASUREMENTS ON PERTHITIC MATERIALS. II. DATA FROM NATURAL ALKALI FELDSPARS: *Jour. Geology*, v. 68, no. 3, p. 307-323, chart, 4 diags., 3 tables, May 1960, 25 refs.

Compositional data and (201) peak-intensity X-ray measurements on 79 alkali feldspar specimens from

intrusive rocks of the western United States demonstrate a considerable variation in the (201) peak-intensity ratios (I_0/I_a , where I_0 refers to the K-rich and I_a to the Na-rich phases) of the perthitic phases comprising the alkali feldspar, such variation being a function of bulk composition and thermal history. In agreement with theoretical expectations, sanidines and incompletely unmixed orthoclase perthites show a higher (201) peak-intensity ratio than orthoclase perthites with a greater unmixing and with similar bulk composition. Microcline perthite specimens having similar bulk composition have even lower (201) peak-intensity ratios, with the exception of a specimen from a mylonite. Under conditions of relatively placid crystallization, it appears that for any bulk composition the lower the temperature-structural state, the lower the (201) peak-intensity ratios. Such variations in (201) peak-intensity ratios are found even in related rocks of a consanguineous igneous sequence, suggesting that studies of this nature may provide a useful isograd-like zoning of many intrusive rocks. Alkali feldspars even within a small intrusive rock unit may show a considerable range in bulk composition.--Auth.

Pt. I of this paper was listed as GeoScience Abstracts 1-3097.

2-1762. Wurman, E. A MINERALOGICAL STUDY OF A GRAY-BROWN PODZOLIC SOIL IN WISCONSIN DERIVED FROM GLAUCONITIC SANDSTONE: *Soil Sci.*, v. 89, no. 1, p. 38-44, 4 figs., 3 tables, Jan. 1960, 11 refs.

The Norden soil series, including well-drained gray-brown podzolic soils is developing in the Reno member of the Franconia formation, St. Croixan series, of Cambrian age. Soils forming from glauconitic sandstone develop iron oxide-rich surface layers and finer textured subsoil layers. The mineralogical study revealed a breakdown of the glauconite to a randomly interstratified illite-expanded mineral material with the release of Fe and K. The ultimate result is a large accumulation of free iron oxide in the surface horizons. The underlying textural subsoil may be formed as the result of illuviation and weathering in place of the glauconite and/or K-feldspar. More than one textural layer might be present, possibly because of a series of perched water tables along denser layers within the glauconitic sandstone. More research is needed to establish the fate of the silica and alumina released by the weathering of glauconite.--From auth. introd. & summ.

2-1763. Nelson, L. A., G. W. Kunze, and C. L. Godfrey. CHEMICAL AND MINERALOGICAL PROPERTIES OF SAN SABA CLAY, A GRUMUSOL: *Soil Sci.*, v. 89, no. 3, p. 122-131, 4 figs., 3 tables, March 1960, 15 refs.

The San Saba clay is an extensive soil type in the Grand Prairie region of central Texas. The San Saba profile, developed in marine sediments, consists of a thick nonilluviated, very dark to black A horizon of calcareous to neutral, very plastic clay, very gradually grading into an olive gray compact, nearly impervious C horizon which consists of Lower Cretaceous marly clay or marl that is often interbedded with thin seams of limestone. Extensive mineralogical and chemical evidence lead to the conclusion that the major changes that have occurred in the course of soil formation are loss of carbonates and accumulation of organic matter in the upper portion

of the profile. The San Saba clay is contrasted with a "typical grumusol," the Houston Black clay, and found to be less clayey, more silty, and with lower exchange capacity. Both soils are dominated by montmorillonite but the San Saba appears to have significantly higher kaolinite. The San Saba meets the requirements of the grumusol concept.--From auth. summ.

2-1764. Byrne, P.J.S., and R.N. Farvolden. **THE CLAY MINERALOGY AND CHEMISTRY OF THE BEARPAW FORMATION OF SOUTHERN ALBERTA:** Research Council Alberta, Geol. Div., Bull. 4, 44 p., illus., 1959, 30 refs.

This paper reports the results of studies undertaken to test the theory that clay minerals undergo diagenetic alteration when transferred from a non-marine to a marine environment. The Bearpaw marine shale [Upper Cretaceous] of southern Alberta was sampled at 3 localities, and the clay-sized fractions of 165 samples were analyzed mineralogically. The samples are composed of montmorillonite, illite, and chlorite, almost always in that order of abundance. No significant relationships were found between the clay mineralogy of the shales and the distance to the ancient shoreline.

Samples were also collected across the formational contact between the marine Bearpaw formation and the underlying nonmarine Oldman formation [Upper Cretaceous]. Chemical and mineralogical analyses of the clay-sized fraction of 45 of these samples show that the Na_2O content of the samples decreases by a factor of 4 from the nonmarine to the marine strata. Only insignificant changes were found in K_2O , CaO , P_2O_5 , and total Fe as Fe_2O_3 . The values for MgO , TiO_2 , Al_2O_3 , and SiO_2 are essentially constant. Illite increases slightly at the expense of montmorillonite, going from the non-marine to the marine strata.

The results offer but slight evidence to support the theory that the sedimentary environment controls the diagenetic alteration of clay minerals. However, this may be partially due to the masking effect of heavy outfalls of volcanic ash which fell into this sedimentary basin during Oldman and Bearpaw time. It is significant that the ash altered to montmorillonite whether it fell into a marine or a non-marine environment. The most remarkable feature of the shales is their mineralogical and chemical uniformity both laterally and vertically.--R.N. Farvolden.

2-1765. Taggart, M.S., Jr., and A.D. Kaiser, Jr. **CLAY MINERALOGY OF MISSISSIPPI RIVER DELTAIC SEDIMENTS:** Geol. Soc. America, Bull., v. 71, no. 5, p. 521-530, map, 4 charts, 3 profiles, table, May 1960, 11 refs.

Late Quaternary Mississippi River deltaic sediments off the coast of Louisiana were studied to obtain information on possible clay-mineral alteration in a marine environment. The samples utilized were cores from 4 foundation test borings and included clays which had been deposited in several environments. For comparison, studies were also made of the clay minerals transported by the Mississippi and Red rivers.

The results support the conclusion that clay minerals do not alter appreciably as a result of diagenesis in a marine environment and that the clay-mineral composition of source sediments determines the clay-mineral content of marine sedimentary rocks. All the deltaic samples contained montmorillonite, illite, kaolinite, and chlorite. The most noticeable variation among the samples was in montmorillonite content. Montmorillonite was the most abundant clay mineral in most of the deltaic samples but was much less concentrated in some of the remaining samples. Variations in montmorillonite content did not correspond with differences in depositional environment. Clays with high montmorillonite content occurred in both essentially marine and fresh-water facies.

Analyses of samples of Mississippi River and Red River sediments indicated that these rivers carry the same suite of clay minerals as is present in deltaic sediments. Furthermore, samples of Red River sediment, characteristically reddish-brown, were predominantly low in montmorillonite content, whereas samples of the gray Mississippi River sediment were high in montmorillonite content. These differences in clay-mineral composition and color correlate substantially with corresponding variations in samples of deltaic sediment.--Auth.

2-1766. Deike, George H., 3d. **X-RAY ANALYSIS OF SOME MISSOURI CAVE CLAYS:** Missouri Speleology, v. 2, no. 1, p. 9-11, Jan. 1960, 3 refs.

Clay samples from Bridal Cave, Money Cave, and Bat Cave, in the Ozarks of Missouri were analyzed by X-ray diffraction technique. Quartz and illite are present in all 3. Kaolinite is present in the clays from 2 (Bridal, Money), hematite in 1 (Money). The clays are the weathering products of dolomite.--M. Russell.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 2-1662; Geochemistry 2-1736, 2-1739; Mineralogy 2-1761.

2-1767. Lapin, V.V., and N.N. Kurtseva. **DIFFERENTIATION OF SILICATE MELTS UNDER INDUSTRIAL CONDITIONS AND THEIR GEOLOGIC SIGNIFICANCE:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 5, p. 48-57, 8 illus., diags., 8 tables, pub. March 1960, 7 refs.

The article deals with the results of large-scale industrial experiments on differentiation of silicate melts of general petrographic interest: 1) The enrichment of the upper levels of the melts in Fe with crystallization of Fe-rich olivine and development of pegmatoid textures; contemporaneous differentiation in lower sections of magnesian olivine; 2) pre-

cipitation of unmelted olivine from the furnace charge into lower levels of the slag with enrichment in magnesium oxide and sharp increase in viscosity of silicate melts containing the solid phase.--Auth.

2-1768. Kruglov, S.S. **DIABASE OF THE DZHEN-TA RANGE AND KHATSAVITA RIVER, NORTHWESTERN CAUCASUS:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 80-81, pub. Feb. 1960, 2 refs.

The author describes some outcrops of diabase discovered during geologic surveys in 1956 in the NW. Caucasus. These outcrops can help in the study of magmatic activity in this part of the Caucasus. The composition of the diabase is given.--LC

2-1769. Kuznetsov, V.A. AGE OF THE ULTRA-BASIC INTRUSIONS OF THE GORNYI ALTAI: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 4, p. 66-74, 3 maps, 2 secs., pub. Feb. 1960, 23 refs.

The presence of Hercynian ultrabasic intrusions in Gornyy Altai has not been confirmed by field data. The Gornyy Altai ultrabasic intrusions are typical products of magmatism of the early stages of development of mobile zones, in this case the Caledonian folded structures of the Altai, and are Cambrian in age. The Cambrian ultrabasic intrusions of Gornyy Altai, like the contemporaneous ultrabasic intrusions of the adjacent Altai-Sayan folded province, originated and were distributed according to certain definite patterns. Associated with them is a complex of useful minerals. A fixing of the age and regularities of distribution of the Gornyy Altai ultrabasic intrusions is of great practical significance, because it would facilitate a proper evaluation of the prospects and a rational approach to the search for useful minerals associated with these intrusions.-- Auth. summ.

2-1770. Ivanov, B.V., V.A. Moleva, and E.I. Gaynanova. ALTERATION OF CRYSTALLINE SCHIST DURING HEATING: Akad. Nauk SSSR, Iz-

vestiya, Geol. Ser., in translation, 1958, no. 5, p. 58-73, 9 illus., 2 graphs, 8 tables, pub. March 1960, 14 refs.

Crystalline schist, incorporated in the refractory lining of a lime kiln, was recrystallized from the liquid state after insignificant, partial development of a glass phase, during operation of the kiln. The initial minerals of the rock, actinolite and albite, were changed to pyroxene, melilite, and plagioclase, and thin microlayers were formed which resemble a microskarn.--Auth.

2-1771. Borodin, L.S. ON THE PROCESS OF NEPHELINIZATION AND AEGIRIZATION OF PYROXENITE AND THE ORIGIN OF ALKALINE ROCKS OF THE IOLITE-MELTEIGITE TYPE: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 6, p. 40-47, 10 illus., map, pub. Apr. 1960, 10 refs.

English translation of GeoScience Abstracts 1-209.

2-1772. Kononova, V.A. THE NEPHELINIZATION OF PYROXENITE AND MARBLE: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 6, p. 48-56, 9 figs. incl. 7 illus., 4 tables, pub. Apr. 1960, 6 refs.

English translation of GeoScience Abstracts 1-210.

10. SEDIMENTARY PETROLOGY

See also: Areal and Regional Geology 2-1657; Geomorphology 2-1673, 2-1674; Stratigraphy 2-1693, 2-1696, 2-1701; Mineralogy 2-1762 through 2-1765; Fuels 2-1861, 2-1869, 2-1879.

2-1773. Boswell, P.G.H. THE TERM GRAY-WACKE: Jour. Sed. Petrology, v. 30, no. 1, p. 154-157, March 1960.

A discussion of the definition and use of "gray-wacke" as a rock name by geologists, with a description of examples such as the Tanner graywacke (Harz Mountains, Germany) and the Aberystwyth grit series (Wales). The most favored descriptive criteria for graywackes are: a) sizing, from conglomerates and breccias to sandstones; b) poor sorting of grains with a substantial quantity of fine matrix; c) rock and mineral fragments very variable in composition; d) grain-shape predominantly angular to subangular.-- D. Carroll.

2-1774. Cavanaugh, R.J., and Carroll F. Knutson. LABORATORY TECHNIQUE FOR PLASTIC SATURATION OF POROUS ROCKS: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 5, p. 628-630, illus., diag., May 1960, 6 refs.

Approximately 100% plastic saturation was obtained with natural rock specimens having permeabilities greater than 0.1 md., using the following impregnation technique: 1) immerse 20 X 20 X 10-mm. specimen in 20 ml. of colored plastic (a 3:1 epoxy-butyl glycidyl ether resin mixture with 10 parts/hundred of diethylenetriamine and 0.4 part/hundred blue dye added); 2) subject the immersed specimen to a 45-min. vacuum and 60-min. 100-125 atm. pressure cycle; 3) allow plastic to gel and then cure at 125°C. for 2 hours.

Complete saturation of samples having appreciable porosity but permeabilities less than 0.1 md. was not obtained even when subjected to pressures as high as 700 atm.--Auth. summ.

2-1775. Bates, John D., and Beth H. Bates. EVALUATION OF HEAVY MINERAL SEPARATIONS USING ARTIFICIAL SAMPLES: Jour. Sed. Petrology, v. 30, no. 1, p. 148-153, 5 tables, March 1960, 8 refs.

In order to evaluate the method of heavy mineral separation used in Coastal Petroleum Company's laboratory work and to compare it with certain other gravity and centrifuge methods, 58 tests were conducted with artificial samples of known concentrations. Samples of 20 and 50 gm. were compared in 1, 2, and 5% concentrations by the separatory funnel gravity method. Samples of 5-gm. size were tested in the same concentrations using and comparing open funnel and separatory funnel gravity methods and double tube and separatory funnel centrifuge methods.

Relatively good results were obtained with both gravity methods and the separatory funnel centrifuge method since mean recovery was above 90%. It was found that for an artificial sample with a median diameter of 2.72 phi of the composition used and with the techniques followed, the separatory funnel gravity method is adequate for our purpose, and it is as good as and perhaps superior to the centrifuge method.-- Auth.

2-1776. Emery, K.O. WEATHERING OF THE GREAT PYRAMID: Jour. Sed. Petrology, v. 30, no. 1, p. 140-143, 4 illus., diag., March 1960, 9 refs.

The Great Pyramid of Giza, Egypt, was built of limestones and limy sandstones of varying resistances to weathering. As a result, the blocks exhibit several different surface textures. When the facing was removed approximately 1,000 years ago, products of weathering formed talus slopes that overflowed the tiers of exposed blocks and banked against the base of the pyramid. An estimate of the rate of formation of talus indicates that the pyramid should remain standing at least 100,000 years unless its destruction is sped by man's activities.--Auth.

2-1777. Sullwold, Harold H., Jr. TARZANA FAN, DEEP SUBMARINE FAN OF LATE MIOCENE AGE, LOS ANGELES COUNTY, CALIFORNIA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 4, p. 433-457, 8 illus., 4 maps, sec., 4 graphs, table, Apr. 1960, 88 refs.

The sandstone beds in the Modelo formation (upper Miocene) exposed on the N. flank of the Santa Monica Mountains were for the most part deposited from turbidity currents. Evidence of rapid deposition is provided by poor sorting, high clay-silt content, grain angularity, high feldspar content, and load deformation. Evidence for great depth of water (about 3,000 ft.) is provided by abundant foraminifers and fish remains in the interbedded shales. That the mechanism for transporting this poorly sorted sand-silt-clay mixture into waters of this depth was that of turbidity currents is borne out by the multitude of syngenetic textures and structures which these rocks have in common with accepted turbidites and with structures which have been produced in laboratory studies.

Some of these structures are oriented with respect to the direction of travel of the current and therefore provide a means of determining the direction of bottom slope along which the currents moved. When plotted on a map these directions reveal a pattern which is unmistakably that of a fan with its apex toward the N. The area studied constitutes a 16-mi.-long section through this outcropping N.-tilted fan. The point source was most logically the mouth of a submarine canyon. The canyon itself is thus far unrevealed, being concealed beneath the alluviated San Fernando Valley, but the eroding source area is tentatively identified on the basis of mineralogical studies in the San Gabriel Mountains about 22 mi. NE. of the fan's apex.

Further studies of this sort cannot fail to provide valuable data on earth history and thus aid petroleum exploration in similar rock types elsewhere in California.--Auth.

2-1778. Curtis, Doris M. RELATION OF ENVIRONMENTAL ENERGY LEVELS AND OSTRACOD BIOFACIES IN EAST MISSISSIPPI DELTA AREA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 4, p. 471-494, 3 pls., 16 maps, chart, table, Apr. 1960, 64 refs.

The concept of defining sedimentary environments in terms of energy levels is applied to interpreting ostracod distribution patterns in recent sediments from the E. Mississippi delta area. "Environmental energy level" represents the amount of energy (mechanical, chemical, thermal, etc.) used in varying the physical and chemical characteristics of the environment. High-energy environments are unstable, with variable physical-chemical conditions; low-energy environments are relatively more stable, with less variable physical-chemical character.

Analysis of ostracod distribution and abundance data shows distinct offshore and inshore biofacies, each recognized by a characteristic ostracod assemblage and different gross faunal characteristics. Offshore biofacies have greater numbers both of species and individuals and a higher number of mature carapaces; many species are restricted to offshore assemblages. Inshore biofacies have fewer species, generally fewer individuals, and mostly immature carapaces; some species are restricted to, and several are most abundant in, inshore assemblages. Offshore energy levels are generally low, inshore, generally high.

The conclusions may be applied in stratigraphic work to interpretation of Tertiary (and possibly Cretaceous) environments and paleogeography.--Auth.

2-1779. Chilingar, George V. NOTES ON CLASSIFICATION OF CARBONATE ROCKS ON BASIS OF CHEMICAL COMPOSITION: Jour. Sed. Petrology, v. 30, no. 1, p. 157-158, 3 tables, March 1960, 5 refs.

Three tables give classifications of limestones and dolomites suggested by Vishnyakov, Teodorovich, and Frolova. The rocks are grouped according to calcite-dolomite and CaO/MgO ratios. Frolova's classification includes mixtures of magnesium dolomites with magnesite as the end-member.--D. Carroll.

2-1780. Chilingar, George V. Ca/Mg RATIOS OF CALCAREOUS SEDIMENTS AS A FUNCTION OF DEPTH AND DISTANCE FROM SHORE: Compass, v. 37, no. 3, p. 182-186, map, 2 graphs, March 1960.

The writer observed that in some localities there is an increase in Ca/Mg ratios of the calcareous sediments with increasing depth and distance from shore. The chemical analyses of sediments from Great Bahama bank and the Persian Gulf demonstrate this relationship.--Auth.

2-1781. Waugh, Wanda N., and Walter E. Hill, Jr. DETERMINATION OF CARBON DIOXIDE AND OTHER VOLATILES IN PYRITIC LIMESTONES BY LOSS ON IGNITION: Jour. Sed. Petrology, v. 30, no. 1, p. 144-147, 3 tables, March 1960, 3 refs.

A loss-on-ignition of limestones to 1,000°C. interrupted at 550°C. for an intermediate weighing provided much of the information needed to calculate carbon dioxide gravimetrically but was complicated by the oxidation of pyrite, which is present in small quantities in many limestones. Upon oxidation pyrite formed Fe₂O₃ and oxides of S which in turn reacted with CaCO₃ below the intermediate temperature to form CaSO₄ and cause a premature evolution of CO₂. It is necessary to determine sulfate S and total S in the raw sample and sulfate S after loss-on-ignition at 1,000°C. In limestones containing 1% or more pyrite, a sulfate determination after ignition at 550°C. is necessary in addition to the other 3 sulfate determinations. These data enable calculation of a true CO₂ value and a single value for all other volatiles gravimetrically in each sample.--Auth.

2-1782. Murray, Raymond C. ORIGIN OF POROSITY IN CARBONATE ROCKS: Jour. Sed. Petrology, v. 30, no. 1, p. 59-84, 15 illus., 4 diags., 15 graphs, March 1960, 27 refs.

Porosity in carbonate rocks results from many processes, both depositional and postdepositional. An understanding of these processes and of the textural history of porosity is necessary to a full appreciation of the history of the rock and is important in the location of potential hydrocarbon reservoir rocks.

Several mechanisms appear particularly important in producing or changing porosity and pore-size distribution in carbonate rocks. Primary interparticle porosity is formed by deposition of a well-sorted calcareous sand or gravel under the influence of strong currents or waves or by local production of calcareous sand-size particles with sufficient ra-

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for many years, and, indeed, having been
removed to the off-shore islands, California
is now left empty. The new wave of
immigration is coming, however, and the
government is now considering the
possibility of allowing the immigration of
immigrants from the off-shore islands.
It is a very interesting and important
question, and the government is now
considering the possibility of allowing
immigrants from the off-shore islands
to be allowed to live in the United States.
It is a very interesting and important
question, and the government is now
considering the possibility of allowing
immigrants from the off-shore islands
to be allowed to live in the United States.

The following information is being furnished to you for your information only. It is not intended to be used for any other purpose. The information is being furnished to you for your information only. It is not intended to be used for any other purpose. The information is being furnished to you for your information only. It is not intended to be used for any other purpose.

I have been thinking of you very much lately, and
 wondering how you are getting on. I hope you are
 well and happy. I have been very busy lately,
 but I have managed to find some time to write
 you. I have been thinking of you very much lately,
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1970s. Although, Robert E. Rouse, owner of the 1000-ton, 1970s Mackinac Islander, an 800-ton St. Ignace Islander and a 1000-ton, 1970s Mackinac Islander, the Mackinac Islander, which was built in 1970, was the last of its kind. The Mackinac Islander, which was built in 1970, was the last of its kind.

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deposition in the beach and dune environments of the upper Tuscarora and upper Keefer sandstones; rounding potency varied markedly from bed to bed. Meta-

morphic rock fragments, because of their low resistance to abrasion, are found to be very useful as environmental indicators.--Auth.

11. GEOHYDROLOGY

2-1790. California, Dept. of Water Resources. REPORT ON PROPOSED ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT, KERN COUNTY: 105 p., 3 fold. col. maps, 24 tables, [Sacramento?], Apr. 1959.

The Rosedale-Rio Bravo water storage district project is intended to replenish local ground-water resources with surplus water to be obtained from the Friant-Kern Canal of the Central Valley project, and from any other sources that may be available, including Kern River and Feather River project. The water storage district covers 43,000 acres of valley floor land N. of the Kern River and W. of Bakersfield, of which approximately 22,000 acres are under irrigation. Present water supply is entirely from ground water; precipitation averages only 5.3 in. annually, and there are no perennial streams. The ground water underlying the district is a part of the general ground-water basin of the San Joaquin Valley. In the Rosedale-Rio Bravo area the basin is free and unconfined by impermeable formations. The chief source of ground-water recharge is the Kern River. The construction of Isabella Reservoir will reduce the amount of flooding which normally helps replenish ground water. Depth to ground water has increased 52 ft. since 1935, half of this since 1954. Overdraft in the basin in 1958 exceeded 50,000 acre-ft. About 2,000,000 acre-ft. of ground water are available in the basin between 100 and 500 ft., to last until additional supplies can be imported under the project. It is concluded that the project is feasible, that reclamation of saline-alkali lands in the district is feasible, that additional imports of water are not immediately needed but should be planned for in the future, and finally that the district as a whole will have a reasonable ability to pay for whatever imported supplies will be required.--M. Russell.

2-1791. Rodis, Harry G., and Robert Schneider. OCCURRENCE OF GROUND WATERS OF LOW HARDNESS AND OF HIGH CHLORIDE CONTENT IN LYON COUNTY, MINNESOTA: U.S. Geol. Survey, Circ. 423, 2 p., pl., 1960.

The report describes briefly the occurrence of ground water of low hardness and of high chloride content in Cretaceous sandstones in southwestern Minnesota. A map shows the locations of wells where field chemical analyses were made; areas where ground water of low hardness occurs; and, by isochlors, the areas where water of high chloride content occurs. The report includes a description of the geologic conditions and discusses briefly the origin of these waters.--Auth.

2-1792. Nebraska, University, Conservation and Survey Division. LOGS OF TEST HOLES, SHERMAN COUNTY, NEBRASKA. Edited by F.A. Smith: 132 p., map, diag., [Lincoln?], 1960.

Logs are based on test holes drilled by the Conservation and Survey Division, University of Nebraska, in cooperation with the Ground-Water Branch of the U.S. Geological Survey during the period 1931-1959 inclusive. This report contains logs of all test

holes drilled in Sherman County under the cooperative ground-water program and includes logs of test holes along the county border in adjacent counties. The county map shows location of all test holes drilled since the beginning of the test-drilling program.

Logs of test holes drilled prior to 1943 in Nuckolls, Webster, Franklin, Harlan, Furnas, Redwillow, Frontier, Hitchcock, and Hayes counties are published in Nebraska Water Resources Survey Paper 1, pts. 1-4. Logs of test holes in Holt County are published in Nebraska Water Resources Survey Paper 2.--From introd.

2-1793. Nebraska, University, Conservation and Survey Division. LOGS OF TEST HOLES, VALLEY COUNTY, NEBRASKA. Edited by F.A. Smith: 121 p., map, diag., [Lincoln?], 1960.

Logs are based on test holes drilled by the Conservation and Survey Division, University of Nebraska, in cooperation with the Ground-Water Branch of the U.S. Geological Survey during the period 1931-1959 inclusive. This report contains logs of all test holes drilled in Valley County under the cooperative ground-water program and includes logs of test holes along the county border in adjacent counties. The county map shows location of all test holes drilled since the beginning of the test-drilling program.--From introd.

2-1794. Price, C.E. "GRANITE" EXPLORATION HOLE, AREA 15, NEVADA TEST SITE, NYE COUNTY, NEVADA - INTERIM REPORT, PART B HYDROLOGIC DATA: U.S. Geol. Survey, Trace Elements Memo. Rept. 836-B, 20 p., 5 graphs, 4 tables, Nov. 1959, ref.

Observations of fluid-loss during drilling and measurements of water-level recovery after bailing and of decline after water injection indicate 2 zones in the granite that are more permeable than the rest of the rock. The hole is entirely above the regional water table. Circulation of air through the hole suggests fairly extensive unsaturated openings between 1,175 and 1,200 ft.--Auth.

2-1795. Reeder, H.O., and others. ANNUAL WATER-LEVEL MEASUREMENTS IN OBSERVATION WELLS, 1951-1955, AND ATLAS OF MAPS SHOWING CHANGES IN WATER LEVELS FOR VARIOUS PERIODS FROM BEGINNING OF RECORD THROUGH 1954, NEW MEXICO: New Mexico, State Engineer Office, Tech. Rept. no. 13, 339 p., illus., 120 maps, 18 graphs, 26 tables, 1959, 188 refs.

This report tabulates the annual measurements of water level in the observation wells in the various irrigated areas, primarily from 1951 through 1955. It summarizes changes in water level by discussion and with an atlas of nearly all the maps of change of water level for the period of record to 1955 for each area in which observations are being made. Included also are hydrographs for the period of record through 1954 of several selected wells in the various areas

GEOHYDROLOGY

ated from ground-water sources. The annual measurements of water level before 1951, seasonal measurements, and daily records of water levels in wells equipped with recording gages have been published in an annual series of U.S. Geological Survey water-supply papers.

The areas of observation included in this report are the House area, Clovis area, Portales Valley, Alamogordo-Lovington-Hobbs area, Roswell basin, Carlsbad area, Estancia Valley, Tularosa-Alamogordo basin, Hot Springs basin, Grants-Bluewater area, Pecos Valley, Playas Valley, and Mimbres Valley. Irrigation has been practiced for many years in arid New Mexico where precipitation is insufficient or too variable for most crops. Surface water from streams was first used for irrigation and recently ground water from wells was also used. As the population has increased and irrigation lands has expanded, water has been used in increasing amounts. And, as the supply of surface water was almost entirely appropriated at an early date and is somewhat fixed, the increased use of water for irrigation, as well as for domestic, stock, municipal, and industrial use, has been supplied mostly from ground-water sources. In New Mexico far more ground water is being used for irrigation than for any other purpose.

The first wells for irrigation in New Mexico were constructed near the end of the 19th century; however, large-scale irrigation was not practiced except in areas of very shallow water or areas in which flowing artesian wells could be developed. The only major use of flowing wells in New Mexico has been in the Pecos well basin where development of ground water for domestic use began in 1891 and for irrigation use, in 1902. Large-scale use of shallow water for irrigation began in the Mimbres Valley about 1908 and in the Portales Valley about 1910. Shallow-water development was expanded somewhat in these and other areas in the late 1920's, but the greatest expansion was about 1946 and has continued through 1954. This report describes each area briefly and gives a short history of its development.

A network of observation wells in which water levels are measured periodically is necessary to record changes in ground-water storage in areas where the ground-water resources are being developed. Such a network provides information on the capacity of the aquifer and the probable life of the wells.

The number of wells in which water levels have been measured annually has increased from 645 in 1938 to 1,450 in 1954. About 1,700 wells were included in the network of observation wells in Jan. and Feb. 1955, all of which, for various reasons, were measured. The number of observation wells in which water levels are measured seasonally has increased from 86 in 1938 to 385 in 1954. The number of observation wells by years and for each area is given in the report under each area heading and shown graphically in the introduction.

In addition to measurements of water levels, other data were collected in connection with the observation-well program. As changes in water level are related to the pumping of ground water, and as more ground water in New Mexico is used for irrigation than for any other purpose, data were obtained on acreage irrigated, quantity of water pumped, and other related factors. As the ground-water body is charged primarily from precipitation, precipitation is an integral factor in the study of changes of water levels. Many of these data and a discussion of their relation to changes of water level are given under each area heading in the report.

Acreage irrigated with ground water in the report areas increased from about 128,000 acres in 1938 to about 420,000 acres in 1954, of which 35,000 acres received water from ground-water sources supplemental to surface water in 1954. The total acreage irrigated in New Mexico in 1954 is estimated at about 820,000, of which about 275,000 acres was irrigated entirely with surface water, 400,000 acres entirely with ground water, and 145,000 acres with a combination of ground water and surface water.

Although precipitation in most of New Mexico is rarely sufficient for the need of most crops, it does supply part of the water requirement and, at such times, reduces the amount of water required for irrigation from surface- and ground-water supplies. Precipitation generally has been below average in most years during the period of observation of water levels. Precipitation data are given for one station in each area discussed in the report.

The amount of water pumped is listed by years under each area heading. About 1,025,000 acre-ft. of water was pumped for use on 420,000 acres of land in the report areas in 1954. A total of about 1,300,000 acre-ft. of water was pumped for use on 545,000 acres of land, 145,000 acres of which received supplemental surface water, in New Mexico in 1954.

With the increased development of ground water it was recognized that some control over development was needed. In 1931, 3 basins were declared by the State Engineer. Other basins have been declared as the need arose since that time.

The trend in water levels from year to year generally has been downward in most areas in New Mexico, especially in the areas where ground water is pumped for irrigation. A notable exception was in 1941 when heavy precipitation greatly reduced the draft on ground-water reservoirs while providing unusually large recharge to them. Water levels rose generally, and by 1942 water levels in some areas were higher than any previously recorded. However, since 1941 the precipitation has been near or below average for most years, causing a new trend of declines in water levels from year to year as more ground water was required for crops, and by 1946-1948 water levels in many wells had reached record lows. In the following years, the increasing number of irrigation wells and, since 1949, the persistent drought have caused somewhat larger net annual declines and successive record-low water levels in general.--H.O. Reeder.

2-1796. Cooper, James B. GROUND WATER IN THE CAUSEY-LINGO AREA, ROOSEVELT COUNTY, NEW MEXICO: New Mexico, State Engineer Office, Tech. Rept. no. 14, 51 p., 12 illus., 6 maps (2 fold.), sec., 6 graphs, 4 tables, 1960, 17 refs.

The Causey-Lingo area, about 300 sq. mi. in extent, is in S.-central Roosevelt County on the High Plains of eastern New Mexico, adjacent to Bailey and Cochran counties, Texas.

A large increase in the use of ground water for irrigation in recent years made it desirable to obtain data on the present use of water and the potentialities for future irrigation. The area was investigated by the U.S. Geological Survey in cooperation with the State Engineer of New Mexico.

Irrigation to supplement precipitation has been practiced on a small scale in the area since 1945. However, the drought of several years' duration preceding 1957 interfered seriously with normal agricultural activities, and successful crop yield

required irrigation. After 1954 the number of irrigation wells increased rapidly, and 86 wells were available in 1956 for irrigation use. Approximately 5,000 acres of land was irrigated in 1956.

The principal water-bearing formation is composed of unconsolidated sand and gravel of Cretaceous age which occur mainly in erosion channels cut into the underlying red beds of Triassic age in the southern and southeastern parts of the area. This aquifer has a saturated thickness in excess of 100 ft. in the deeper parts of the channels. Less permeable consolidated rocks of Cretaceous age overlie the Triassic red beds in the remainder of the area and yield only small amounts of water to wells. The Ogallala formation of Tertiary age mantles the Cretaceous formations and, in most of the area, yields only small quantities of water to wells.

Irrigation wells in the Causey-Lingo area range in depth from 103 to 272 ft. and in yield from less than 100 to more than 1,500 gallons per minute (g.p.m.). The average depth of the irrigation wells is 150 ft. and the average reported yield is about 500 g.p.m. Both the depths and yields vary widely over the area.

Measurements of water levels in wells in Jan. 1957 indicated that throughout the area water level was generally lower than in Jan. 1956. The average decline was 2.6 ft. and the decline in individual wells ranged from 0.3 ft. to 10.1 ft.

The ground water is hard and high in fluoride but is suitable otherwise for most domestic uses. In most of the area, wells yield water satisfactory for general irrigation use. However, water from wells believed to be finished in the consolidated rocks of Cretaceous age in the northern part of the area is of a type which, with continued irrigation use, may increase the proportion of alkali in the soil and result in conditions adverse to plant growth.

The potential for additional irrigation development is greatest in the southern part of the area, both E. and W. of Lingo, where fairly large supplies of ground water are believed to be present in the unconsolidated sand and gravel of Cretaceous age, and where no irrigation wells were in operation at the time of this investigation.--Auth.

2-1797. Winn, Robert M. CLARIFICATION OF LAKE WATER PRIOR TO ARTIFICIAL RECHARGE BY WELLS: Compass, v. 37, no. 4, p. 278-298, 7 figs. incl. illus., diagrs., table, May 1960, 15 refs.

During a year of average rainfall on the High Plains of Texas approximately 1,400,000 acre-ft. of water collects in the myriad shallow playa lakes which dot the surface of the plains. Conservation of this runoff water is imperative. Artificial recharge of the underground reservoir with the surface water provides a partial answer to the storage problem.

Prior to recharge, the turbid lake water must be cleared of suspended solids to prevent clogging of the well and the aquifer. The chemical flocculating

agent, Separan AP-30, was used for clearing the water. Separan AP-30 is an organic, nonionic polyacrylamide; prepared and furnished by Dow Chemical Company.

Various methods of applying the chemical to the turbid water were conducted. First, a dilute, aqueous solution of the polymer was tested. This solution was mixed with the water in various proportions. Results indicated that less than 50% of the suspended solids were removed. Second, the dry, powdered form of the chemical was used. This was applied to the lake surface by an airplane equipped for such work. More than 76% of the suspended solids were removed by this method.

Water clarification has long been an established practice. However, this is a preliminary study of clearing playa lake water of suspended solids by a chemical agent prior to artificial recharge by means of wells.

The economy of the High Plains is dependent upon the available supply of ground water. The gain in the amount of water available for irrigation and industrial use and the recovery of land more than offsets the expense of the recharge operation.--Auth.

2-1798. Cullinan, Thomas A. PRELIMINARY STUDY ON THE MOVEMENT OF SILT AND CLAY IN A WATER-BEARING FORMATION: Compass, v. 37, no. 4, p. 299-314, 5 figs. incl. illus., maps, graphs, 2 tables, May 1960, 12 refs.

The problem of a future water shortage on the southern High Plains of Texas is a serious one. The economy of the region depends on an adequate ground water supply, and the current demands far exceed the amounts being replenished through natural recharge. At the same time, large amounts of water are being wasted through evaporation from the numerous playa lakes of the area. One of the means under study to forestall a shortage of water in future years is to utilize this playa lake water by storing it in the ground through artificial recharge by means of wells.

One of the problems connected with artificial recharge by means of wells in this area is that of the clogging of the aquifer caused by the suspended particles and their effect on the water-bearing formation.

Recharge and pumping tests were conducted on March 12 and 13, 1959, at a multiple-purpose well located near the town of Halfway, Texas. Samples were collected from observation wells nearby and analyzed in the laboratory by means of the pipette method of analysis. Efforts to trace the movement of the various sized particles within the aquifer were unsuccessful because the weight of suspended solids per unit volume of water was too low.

In a comparison with previous tests, it was determined that a higher percentage of clay-sized particles can be removed from the aquifer by surging the well during the pumping cycle. Other practices for prolonging the life of a recharge well are also mentioned.--Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 2-1651; Areal and Regional Geology 2-1654; Stratigraphy 2-1690; Geophysics 2-1721; Geochemistry 2-1740, 2-1750; Engineering Geology 2-1889.

2-1799. Hartman, Howard L., ed. PROCEEDINGS OF THE NINTH ANNUAL DRILLING SYMPOSIUM.

THEME: EXPLORATION DRILLING. OCTOBER 8-10, 1959: Pennsylvania State Univ., Mineral Industries Expt. Sta., Bull. no. 72, 126 p., illus., secs., diagrs., graphs, tables, March 1960, refs.

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- Qvale, R. B. The Special Drilling Techniques and Equipment Developed and Used for Drilling Associated with Underground Testing of Atomic Devices at the Nevada Test Site, p. 115-118.
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- Singh, Madan Mohan. Slim Holes, Large Holes, Air Drilling, and Drilling in Unconsolidated Materials, p. 123-124.
- Mickle, David. Bit Design, p. 125.
1800. Dressel, Waldemar M., and Roy Austin Ritchey. FIELD TEST FOR BERYLLIUM: U.S. Bureau of Mines, Inf. Circ. 7946, 5 p., illus., 1960.
- A simple, reliable field test for Be in rocks has been developed by the Rolla [Missouri] Metallurgy Research Center of the U.S. Bureau of Mines. A small portion of the pulverized rock is fused with a sodium carbonate-sodium hydroxide flux in a wire loop. The fused mass is dissolved in water, a few drops of quinizarin solution are added, and the solution is viewed under ultraviolet light. A pink-to-orange fluorescence reveals the presence of Be in a sample containing as little as 0.013% Be (0.26% beryl).--Auth. summ.
1801. Baranov, V. I., and V. K. Khristianov. BORON PROFILES BY THE NEUTRON METHOD: Geokhimiya [in translation], 1958, no. 7, p. 849-850, graph, pub. 1960?, 3 refs.
- A 1×10^7 n/sec. neutron source is placed under a water reflector at a distance of 24 cm. from a direct neutron detector. The detector, together with the measuring instrument, slides on the surface at the rate of 4-5 km. per hour, creating a sliding soil-water contact. This increase of the boron oxide concentration in the soil by 0.01% corresponds to the decrease of the neutron flux density by 5% relative. The method can be used for studying the distribution of B in soil for the purpose of speedily defining perspective areas during prospecting for new borate deposits.--Auth.
- 2-1802. Safronov, N. I., V. V. Polikarpochkin, and A. A. Utgof. SPECTROGRAPHIC AUROMETRIC SURVEYING AS A METHOD OF PROSPECTING FOR GOLD ORE DEPOSITS NOT ACCOMPANIED BY MECHANICAL HALOS (PLACERS). Translated by William Mandel: Internat. Geology Rev., v. 2, no. 3, p. 254-258, 2 profiles, table, March 1960, 5 refs.
- At present, metallometric surveying is employed in prospecting for most of the commercially useful metals; for Au, however, this method had not been found practical. It has been assumed that all Au deposits are identifiable by gravimetric survey from their mechanical dispersion halos, and, as Au is inert, identifiable in the supergene zone by its resistance to chemical change and migration. In addition, there have been available no analysis methods comparable in sensitivity and efficiency to those of gravimetric survey. Analysis methods for Au must show content of at least 0.05 g. per ton ($5 \times 10^{-6}\%$), and a safety factor, in addition, of twice that amount, or $2-3 \times 10^{-6}\%$. Standard emission-spectral analysis has proven inadequate as has chemical analysis with respect to time consumption, expense, and degree of sensitivity.
- A combined chemical-adsorption spectral analysis of metallometric Au samples tested by VITR in 1956 was found to have the sensitivity (0.03 g. per ton, or $3 \times 10^{-6}\%$) as well as economy of operation necessary for general use. Essentially, this analysis process involves enrichment, accomplished in 2 stages, of a sorbent material with Au from analysis samples. The Au-enriched sorbent is analyzed by ISP-22 or ISP-28 quartz spectrograph, and the results interpreted visually by comparison of spectra with those of the standard specimen (prepared immediately preceding the analysis process). In 1956, VITR completed a successful field-control test of this combined-analysis method in eastern Transbaikal. Au dispersion halos, undetected previously by the usual spectral-analysis method (without the concentration process), were located near the deposit. Concentration of Au in these halos was 0.05 g. per ton.
- Further investigation may make it possible to prospect for Au by testing certain plant species, thus utilizing the data on Au content of plants.--D. D. Fisher.
- 2-1803. Brummer, J. J. A RECONNAISSANCE GEOCHEMICAL SURVEY IN THE SEAL LAKE AREA, LABRADOR: Can. Mining & Metall. Bull., v. 53, no. 576, p. 260-267, 7 illus., 4 maps, table, Apr. 1960, ref.
- A reconnaissance geochemical survey, using the

stream sediment technique, is described. The survey covered an area of about 400 sq. mi., in the Seal Lake area of central Labrador, underlain by basaltic flows, diabase and metadiabase sills, and sedimentary rocks. Previous work had indicated numerous small Cu occurrences within the Seal Lake group of rocks. Stream sediments were tested for the readily extractable Cu content and total heavy metal content. The results of the Cu survey did not yield any new data on the distribution of Cu mineralization. Results of the total heavy metal survey attracted attention to a remote portion of the area (Ten Mile Lake), which had hitherto been regarded as having no economic interest. The anomalous values found suggested that Zn mineralization should occur in this region. Geological mapping indicated that the rocks exposed belonged to the Letitia Lake group, which is older than the Seal Lake group exposed to the E., which contains the Cu mineralization of the district.

Investigation of the area led to the discovery of: 1) uneconomic Pb-Zn mineralization; 2) radioactivity extending over a considerable area. Evaluation of the radioactive rocks led to the discovery of Nb-Th mineralization in amphibolite and in diopside-actinolite schists along a contact with intrusive alkali syenite.

Thus a geochemical survey, which was planned to evaluate a Cu province, resulted in the discovery of Pb-Zn-Nb-Th mineralization.--Auth.

2-1804. Kraynov, S.R. USE OF SURFACE FLOW OF SPRING WATER FOR HYDROCHEMICAL PROSPECTING OF ORE DEPOSITS. Translated by William Mandel: *Internat. Geology Rev.*, v. 2, no. 3, p. 259-262, 3 graphs, 2 tables, March 1960, 3 refs.

Small streams fed by subsurface run-off, subject to ore-oxidation activity, alter in chemical composition and are thus useful in hydrochemical prospecting for ores. Surface-flow types most favorable to hydrochemical prospecting are identified and the optimum time of the year established for positive identification of oxidizing-ore occurrences by surface-water chemical composition.

The author chose the Lory plateau in northern Armenia as the area of investigation. The topography is mountainous; elevations above sea-level range from 1,100 to 2,700-2,800 m. Its climate is temperate alpine, and the annual precipitation of 650 to 750 mm. is heaviest during Apr.-June. Sedimentary and effusive tuffs of Middle Jurassic to middle Eocene age contain numerous polymetallic, chalcopyrite, Cu-As, pyrite, and other ores; minerals are principally sulfides. A high-intensity water cycle resulting in abundance of springs and surface flows is characteristic of the region. For the regional run-off zones of underground flow, mineralization is as high as 500 mg. per liter. Oxidizing ores affect chemical composition only of waters from the local run-off zone. The major-stream type of surface flow is more highly mineralized than the autonomous-stream type and has greater discharge. Major-stream flow is subdivided into streams which collect their waters above local base level by discharging aquifers of the local run-off zone and streams of regional significance in which waters from the regional run-off zone are important. Changes in chemical composition are most significant in autonomous-stream types at low water level. Chemical composition of surface flow is influenced by oxidizing ores where stream waters originate above the local base level, but not where waters originate below base level. Degree of change in chemical composition of autonomous-stream waters

depends upon mineralogical composition of ores. Change in chemical composition of major streams may attest to the presence of ore deposits, but it is a very poor indicator of mineralogical composition. The most definite identification of mineralized areas by surface water chemical composition occurs during low water.--D.D. Fisher.

2-1805. Polikarpochkin, V.V., V.I. Kasyanova, A.A. Utgof, and L.F. Cherbyanova. GEOCHEMICAL PROSPECTING FOR POLYMETALLIC ORE DEPOSITS IN THE EASTERN TRANSBAIKAL BY MEANS OF THE MUDS AND WATERS OF THE DRAINAGE SYSTEM. Translated by William Mandel: *Internat. Geology Rev.*, v. 2, no. 3, p. 236-253, 8 maps, 8 profiles, diag., March 1960, 11 refs.

In 1956, the All-Union Scientific Research Institute for Prospecting Methods and Equipment (VITR) and the Chita Geological Bureau conducted joint studies to develop a prospecting method for polymetallic ore occurrences using muds and waters of the regional drainage system in eastern Transbaikai. The region is dry with distinctly continental climate; precipitation, averaging 330 mm. per year, is proportionately heavier during the summer season. The Nerchinsky Zavod district, selected for study, is hilly with absolute elevations of 600-850 m., cut into ridges by NE.-SW.-trending ravines, and characterized by a mature drainage system. Permafrost islands are widespread, and vegetation is transitional between steppe and taiga types. Lower Paleozoic, Silurian, and Lower and Middle Jurassic sedimentary rocks occur to the W. along with granite bodies and other intrusives. To the E., Lower Cretaceous sediments are extensive; Tertiary and Quaternary effusives appear, and Proterozoic and lower Paleozoic metamorphic rocks are exposed over an extensive area along the Serebyanka river.

Most ore occurrences are to the W. in upper and lower Paleozoic, principally carbonate, rocks. Galena, sphalerite, and pyrites occur in carbonates and some quartz as lenses, veins, and irregular bodies. Limonite is predominant among oxidized ores, which include manganese oxides. Pb, Zn, Ag, As, and Sn content is high; Sb and Cd are present. The following conclusions have been developed from preliminary work. Dispersion halos in stream-bed muds reflected occurrence and composition of polymetallic ore deposits on the sides of ravines. Small and medium-sized deposits were found to have halo heads as long as 4.5 km. and trains as long as 2.5 km., according to the degree of sensitivity obtained by analysis. It was concluded that simultaneous determination for several elements is desirable, as well as sampling in 2 stages to reduce work volume: i.e., general sampling at 200-m. intervals to establish presence of ore-bearing valleys, and 50-100 m. interval sampling to discover halos for individual deposits. Polymetallic deposits are identifiable by high ΣM (sum of metals present), or, essentially, the Zn content because of its widespread dissemination in natural waters in underground and surface waters. No false ΣM anomalies, not related to ore deposits, were encountered. Sampling of alluvium and talus waters and of country rock waters yielded identical results.

It was established that hydrochemical prospecting should be during rainy periods when many springs appear in alluvium and talus; however, frequent and brief precipitation may complicate sampling results. Possible contamination of samples must be avoided, especially in sampling surface waters. Thus, hydro-

chemical prospecting for polymetallic ore deposits by sampling stream-bed muds proved to be particularly adapted to the regional conditions of eastern Transbaikal. A comparatively small number of samples is needed to find ore-bearing districts, probably 1/10 that required for areal metallometric survey of alluvium and talus on the usual 1:50,000 scale. In addition, muds of underground and surficial waters may reflect blind deposits not identifiable by metallometric surveys of talus. Heavy or extensive equipment, power source, or fuel haulage are not required; thus, analyses can be run by most field parties. Analysis methods have been developed for only a small number of elements. It is planned to develop these methods for use under a wider range of environments and for use of indicators for a large variety of metal complexes.--D. D. Fisher.

2-1806. Gill, James E., chairman. SYMPOSIUM ON THE GENESIS OF MASSIVE SULPHIDE DEPOSITS: Can. Mining & Metall. Bull., v. 52, no. 570, p. 610-649, 19 illus., 6 maps, 2 charts, sec., 12 figs., 3 graphs, 8 tables, Oct. 1959, refs.

The development of ideas about the genesis of mineral deposits is of great practical importance in mineral exploration. Important deposits undoubtedly have been overlooked because of incorrect or incomplete theories about their origin. A review of the ideas relating to the origins of sulfide deposits is important because such deposits play a tremendous role in the Canadian economy. In order to keep discussion within reasonable bounds and to focus attention upon the great mass of new data made available through the intensive mineral exploration of the past few years, the study is restricted to massive sulfide deposits.--P. R. Eakins.

The 5 papers are abstracted separately below in the order in which they appear. Discussion by J. E. Hawley, J. B. Mawdsley, and W. L. W. Taylor concludes the symposium.

2-1807. Gunning, H. G. ORIGIN OF MASSIVE SULPHIDE DEPOSITS (In: Gill, James E., chairman. Symposium on the Genesis of Massive Sulphide Deposits: Can. Mining & Metall. Bull., v. 52, no. 570, p. 610-613. Oct. 1959) 10 refs.

A review of current hypotheses of the origin of ore deposits. Types and examples of deposits, genesis of the sulfides, Cu-Ni sulfide deposits, and Cu and Cu-Zn deposits are discussed.--P. R. Eakins.

2-1808. Sullivan, C. J. THE ORIGIN OF MASSIVE SULPHIDE ORES (In: Gill, James E., chairman. Symposium on the Genesis of Massive Sulphide Deposits: Can. Mining & Metall. Bull., v. 52, no. 570, p. 613-619, 3 figs., table, Oct. 1959) 7 refs.

This paper does not attempt to cover the subject completely, but to suggest the following aspects:

1) Some types of metalliferous provinces and deposits result from the prior accumulation of metals in sediments. Particular sedimentary environments commonly produce particular types of metalliferous provinces. Ores associated with marine shales and tuffs, reef facies, red beds, and other sedimentary environments, are discussed.

2) Particular types of basic igneous rocks are associated with particular types of metalliferous deposits and provinces.

3) The formation of sulfide ores results, principally, from the application of heat to bodies of rock containing dispersed quantities of metals. The sep-

aration of sulfide and silicate phases depends on relative thermal stabilities, not on solubility in water. The separation may take place from a magma (as in volcanic ores), or from comparatively solid rocks (as in metamorphism and granitization). Temperature zoning and mineral paragenesis reflect the thermal stability ranges of the minerals, not their relative solubilities in water.

4) Favorable rocks for replacement by ore are those which react, and may be metamorphosed, at comparatively low temperatures. Permeability and porosity are of secondary importance only.

5) The deposition of ore near a source (e. g. a stock), depends on the existence of a rapid temperature gradient, characteristic of local, rather than of regional, metamorphism, and of the cordilleras rather than of the shields.

6) Water is associated with ore deposition, principally because it is one of the most common thermally unstable compounds in the earth's crust, and thus accompanies the relatively thermally unstable sulfides. Water is also a powerful catalyst.

7) Volcanic centers, having little in common with sedimentary accumulation and regional metamorphism, are major foci for sulfide accumulation. Such centers commonly occur along lines of deep crustal weakness.--Auth.

2-1809. Wilson, H. D. Bruce, and D. T. Anderson. THE COMPOSITION OF CANADIAN SULPHIDE ORE DEPOSITS (In: Gill, James E., chairman. Symposium on the Genesis of Massive Sulphide Deposits: Can. Mining & Metall. Bull., v. 52, no. 570, p. 619-631, 3 maps, 12 figs., 3 graphs, 7 tables, Oct. 1959) 20 refs.

Canadian sulfide deposits generally have characteristic compositions. Metal associations in ore deposits and in igneous rocks are similar.

Ni-S ratios, Cu-Ni ratios, and Ni-Co ratios in Cu-Ni sulfide ores are characteristic for most ore bodies. Ni, as sulfide, is highest in ores associated with ultrabasic rocks, whereas Cu is highest in ores associated with gabbros. Co is relatively constant.

The metal ratios in Cu-Ni ores are due: 1) to the composition of the related igneous rock or magma; 2) to the partition ratios of the metals into the sulfides when separating from the silicate rock or magma; and 3) to the conditions at the time of deposition. Each factor is discussed and the evidence indicates the Frood ore body is a magmatic segregation in place and Falconbridge is an injected sulfide melt.

Many Canadian ore bodies containing Cu, Zn, or Pb also have relatively constant compositions. Cu and Zn are concentrated in gabbro and diorite, and Cu-Zn ores in northwestern Quebec are spatially related to gabbros and diorites. The same 3 factors controlling metal ratios in Cu-Ni deposits should control the metal ratios in Cu-Zn deposits if the metals come from the gabbro-diorite intrusions.

The ratios of base metals in common sedimentary rocks are not similar to the ratios in ore bodies. Base metal elements are mobilized during high-grade metamorphism, but much fundamental research is needed before the relation between metamorphism and ore deposits can be established on a sound basis.

The distribution of elements in sulfide ore bodies suggests that Cu, Zn, and Pb are deposited simultaneously in relatively constant proportions rather than successively in a paragenetic sequence. Zoning may be due to different ratios of metals being deposited under changing temperature, pressure, and chemical environment, or may be the result of other processes.--Auth.

2-1810. Stanton, R.L. MINERALOGICAL FEATURES AND POSSIBLE MODE OF EMPLACEMENT OF THE BRUNSWICK MINING AND SMELTING ORE-BODIES, GLOUCESTER COUNTY, NEW BRUNSWICK (In: Gill, James E., chairman. Symposium on the Genesis of Massive Sulphide Deposits: Can. Mining & Metall. Bull., v. 52, no. 570, p. 631-643, 16 illus., Oct. 1959) 36 refs.

A number of recent papers have dealt with the grosser features of some of the New Brunswick deposits - their form, structural affiliations, and regional pattern of distribution. The present study has been restricted to 2 of these deposits - the Brunswick Mining and Smelting Corporation's No. 6 and No. 12 ore bodies - and is concerned chiefly with microscopical features, and their significance. As such it may be regarded as complementary with the paper by Lea and Rancourt on form and field occurrence.

The ores are of banded pyritic type, major constituents other than pyrite being magnetite, pyrrhotite, sphalerite, galena, and chalcopyrite. Associated minor minerals include tetrahedrite-tennantite, arsenopyrite, enargite, and others, most of which are present in only minute amount. The ore-bearing rocks are low-grade metamorphic quartz-carbonate-chlorite-sericite assemblages containing variable quantities of magnetite, sulfides and C. Thin-section studies to date show no clear preference of sulfide for rock bands of any particular composition.

The possibilities that the sulfides and their textures, as they now occur, have formed alternatively by replacement of nonopaque rock-forming minerals, by replacement of magnetite, by deformation of previously occurring minerals, or by the metamorphic reconstitution of sedimentary sulfides, are examined. It is suggested that the last may have been the case, and that the present ores are simply sulfide metamorphic rocks, the actual minerals and their textures having developed during the compaction and folding of the containing sediments. On this basis the present textures represent a sulfide crystalloblastic series rather than a sequence of deposition from solution (paragenesis).

Taking into account both field and microscopical evidence, it is submitted that the 2 deposits may have resulted from an interplay of sedimentary and volcanic factors; submarine and seaboard volcanic fumaroles and springs may have contributed large quantities of metallic halides, sulfides, and other S compounds to a sedimentary facies particularly conducive to reduction. The fumaroles were simply a further manifestation of the known volcanism of the area, and the particular facies involved was - as is evidenced by the abundant C and carbonate in the present metasediments - one of relatively high biological activity. Where these conditions were fulfilled in zones of fairly quiet and undisturbed sedimentation (minor shelf depressions and lagoons) the sulfides may have built up as cryptocrystalline mixed precipitates, which were later buried by further pyroclastic and other sediments. With compacting and folding, the present mineral structures and textures may have developed concurrently with the diagenesis and metamorphism of the enclosing rocks. --Auth.

2-1811. Watson, K.D. ORIGIN OF BANDED STRUCTURE IN SOME MASSIVE SULPHIDE DEPOSITS (In: Gill, James E., chairman. Symposium on the Genesis of Massive Sulphide Deposits: Can. Mining & Metall. Bull., v. 52, no. 570, p. 643-646, 3 illus., 3 maps, Oct. 1959) 9 refs.

Banding is a common structure in fine-grained massive sulfide deposits due to variations in the proportions of ore to gangue, proportions of individual sulfide minerals, or the grain sizes in various bands. Many ways of formation of such banding have been visualized - selective replacement of layered rocks, deposition in closely-spaced parallel fractures, deposition by sedimentary processes, mylonitization, metamorphic differentiation, gliding and recrystallization flowage, and variation in the rates of mineral deposition - but there seems to be a scarcity of valid criteria for determining in which of the ways it did originate.

The banding of fine-grained sulfides at the Mind-amar Zn-Pb-Cu mine, Cape Breton Island, Nova Scotia, is described in detail. The banding appears to have resulted mainly from selective replacement of relic lamination in sericite schist and partly from replacement controlled by closely spaced parallel fractures in sheared sericite-rich layers. --P.R. Eakins.

2-1812. GILL, James E. SYMPOSIUM ON THE OCCURRENCE OF MASSIVE SULPHIDE DEPOSITS IN CANADA. PART I. INTRODUCTION: Can. Mining & Metall. Bull., v. 53, no. 574, p. 75-76, Feb. 1960.

With the slackening of the pace of activities in Canadian mineral exploration, the present time seems to be an appropriate one in which to marshal and interpret the vast amount of data gathered over the past decade. This period was marked by the appearance of the airborne electromagnetometer - a device designed to find hidden massive sulfide deposits - and booming base metal prices. Many new deposits of massive sulfides were discovered in this period.

The need on the part of private companies and governmental agencies to collect and report on ore deposits, ore showings, and barren sulfide zones must be emphasized and must be considered as vital to self-interest as well as to national and scientific ends. --P.R. Eakins.

2-1813. Baird, David M. MASSIVE SULPHIDE DEPOSITS IN NEWFOUNDLAND (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 574, p. 77-80, map, 2 tables, Feb. 1960) 13 refs.

Three quarters of the hundred-odd sulfide occurrences are in the Central Mineral Belt of Ordovician sedimentary and volcanic rocks, a triangular area with one side along the N.-central shore of the island. In this area the sulfides occur for the most part as replacement lenses and pods in sheared intermediate to basic volcanic rocks. Some are associated with brittle horizons in more plastic sequences, such as rhyolite flows in chloritized andesites. Some have been found only in certain beds in mixed stratigraphic sequences and appear to have been controlled by stratigraphy or lithology.

The deposits at Buchans, Tilt Cove, Pilley's Island, Little Bay, and Terra Nova are discussed. --P.R. Eakins.

2-1814. Keating, B.J. MASSIVE SULPHIDE DEPOSITS IN NOVA SCOTIA (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 574, p. 81-87, illus., map, Feb. 1960) 23 refs.

the 3 principal massive sulfide deposits at Stirling (Samar), Smithfield, and Walton are described briefly, and their genesis is discussed. The sulfide occurrences of Nova Scotia are classified as a whole into three principal types: 1) pyrite-sphalerite-chalcopryrite mineralization in pre-Carboniferous volcanics (e.g. Stirling); 2) pyrite-sphalerite-chalcopryrite mineralization in Mississippian sediments (Smithfield and Walton); 3) sphalerite-pyrite-peridotite mineralization in pre-Carboniferous crystalline limestones; and additional types 4) chalcocite-chalcopryrite mineralization in Carboniferous sediments; 5) specular hematite-pyrite-chalcopryrite mineralization associated with post-Horton basic intrusions.--P. R. Eakins.

15. McAllister, A. L. MASSIVE SULPHIDE DEPOSITS IN NEW BRUNSWICK (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 574, p. 88-98, 12 maps, 6 secs., 2 tables, March 1960) 17 refs.

Massive sulfides are found in 2 areas - the south-western Stephen district and the N.-central Bathurst-Newcastle district. The St. Stephen's occurrences are essentially disseminations with some lenses of pyrrhotite or nickeliferous pyrrhotite with pentlandite, chalcopryrite, and pyrite, associated with a differentiated gabbro-anorthosite-peridotite mass. A detailed, illustrated review of the geology of Bathurst-Newcastle Cu-Pb-Zn deposits makes up the bulk of the paper.

The author suggests that the sulfides were deposited as a facies of Fe formation in isolated basins which existed in numerous places throughout an irregular topography.--P. R. Eakins.

16. Gilbert, J. E. DISTRIBUTION AND GENERAL CHARACTERISTICS OF THE MASSIVE SULPHIDE DEPOSITS OF THE PROVINCE OF QUEBEC (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 575, p. 128-135, 2 tables, March 1960) 14 refs.

The geology of 26 deposits in the Precambrian Appalachian regions of Quebec are reviewed under the headings: ore minerals, host rocks, wall-rock alteration, structural control, and shape of deposits. The author remarks on the scantiness, shaltness, and inaccuracy of much of the available information.--P. R. Eakins.

17. Thomson, James E. MASSIVE SULPHIDE OCCURRENCES IN ONTARIO (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 575, p. 136-140, map, table, March 1960) 8 refs.

A general review of the principal massive sulfide occurrences of Ontario which covers classification of massive sulfide occurrences; genesis of sulfide deposits, including the Goudreau, Manitouwadge, and Long Lac, Consolidated Sudbury basin, and Cobalt-Stobie; and genesis of massive sulfides. Some general conclusions are drawn. 1) Massive sulfides almost always occur with other types, such as disseminated, breccia, or stringer. 2) Any statistical analysis such as shown in this paper indicates that, in general, every sulfide deposit has an individuality of its own. 3) Sulfide deposits, as presently constituted,

are of the hydrothermal type. 4) The early geological environment may be an important factor in the regional distribution of sulfide deposits. The fact that many occur in areas of transition from volcanism to sedimentation or in areas of Pelean volcanism may have some genetic significance. Early stratigraphic localization of sulfides in such environments and later concentration by "sweating out" during intrusion and metamorphism may have a considerable bearing on the distribution of mineralized districts.--From author, concl.

2-1818. Davies, J. F. MASSIVE SULPHIDE DEPOSITS IN MANITOBA (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 575, p. 141-144, map, table, March 1960) 6 refs.

Massive sulfide deposits of several different mineral assemblages are found in 6 Precambrian areas; Lynn Lake, Burntwood River, Sherridon, Flin Flon, Snow Lake-Herb Lake, and Bird Lake. The deposits of each area are described briefly. An outstanding feature is the number of deposits in metamorphosed sedimentary rocks. Strong wall-rock alteration typifies deposits in volcanic rocks, but is lacking, or present in limited amounts, around the deposits in sedimentary rocks.

The Ni-bearing deposits are without dispute genetically associated with gabbro and peridotite deposits. Most of the other deposits appear closely related to the intrusion of granite rocks.--P. R. Eakins.

2-1819. Byers, A. Roddick. SULPHIDE DEPOSITS IN SASKATCHEWAN (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 575, p. 145-152, 4 maps, table, March 1960) 28 refs.

This paper describes the distribution, occurrence, and paragenesis of known sulfide deposits within an area bounded by 102°-106°W. 54°30'-57°N. The Precambrian bedrock which outcrops over all but the southern fringe of the area consists of regional metamorphic assemblages ranging from low-grade or green schist facies to high-grade or amphibolite-granulite facies. The areas of low-grade metamorphism correspond to "islands" of volcanic rocks which are surrounded by high-grade paragneisses and migmatites. Intrusive rocks range in composition from ultrabasic to granitic and may be divided into syntectonic and post-tectonic sequences. The average composition of the former is granodiorite and of the latter quartz diorite.

The massive sulfide deposits fall naturally on basis of mineral content into the following divisions: 1) pyrrhotite and/or pyrite, 2) sphalerite and/or chalcopryrite plus iron sulfides, 3) sphalerite and galena, 4) sulfide-bearing pegmatite, and 5) nickeliferous pyrrhotite and/or chalcopryrite.

The deposits of iron sulfides are ubiquitous. Ratio of pyrrhotite to pyrite is fairly constant for individual deposits, but their areal distribution appears to be independent of the nature of the enclosing rock and grade of regional metamorphism. All deposits containing ore-grade quantities of base metals have been concentrated at favorable structural locations. Cu-Zn and Pb-Zn deposits appear to be associated with syntectonic granodiorite with the Pb-Zn concentrations confined to calc-silicate gneisses. Cu-Ni deposits show a close relationship to post-tectonic gabbros and pyroxenites. The paragenesis

is more or less the same for the majority of deposits, with iron sulfides and sphalerite being introduced early and followed by chalcopyrite and galena. Some vertical and/or horizontal zoning is apparent in a few deposits. Temperatures of formation and origin of the deposits are briefly discussed.--Auth.

2-1820. Campbell, Neil, and W. T. Irvine. MASSIVE SULPHIDE ORES IN BRITISH COLUMBIA: (In: Gill, James E. Symposium on the Occurrence of Massive Sulphide Deposits in Canada: Can. Mining & Metall. Bull., v. 53, no. 575, p. 153-156, 2 diags., table, March 1960) 5 refs.

The metalliferous deposits of British Columbia are largely confined to that portion of the Cordilleran province lying W. of the Rocky Mountain trench. Massive sulfides in the coastal area carry important Cu values together with Pb and Zn and are composed mainly of pyrite which replaces schists or shear zones. The massive sulfide ore of the interior contains Pb and Zn with little Cu. Pyrrhotite rather than pyrite is the dominant metallic, and deposition took place through selective replacement of sedimentary beds.--Auth.

2-1821. Stanton, R. L. GENERAL FEATURES OF THE CONFORMABLE "PYRITIC" OREBODIES. PART I. FIELD ASSOCIATION: Can. Mining & Metall. Bull., v. 53, no. 573, p. 24-29, Jan. 1960, 13 refs.

The present contribution examines, in some detail, what appear to be the 3 outstanding features of the field occurrence of the conformable "pyritic" deposits. These are their association with fragmental volcanic rocks (and derivatives), their occurrence in sediments of nearshore formation, and their highly variable structural associations.

In a recent paper it has been suggested that 2 such "pyritic" deposits in New Brunswick may have originated as marine concentrations of volcanic base metal and S compounds, and that many of their present features are the result of diagenesis, folding, and regional metamorphism. This is now put forward as a general explanation for the particular class of deposit considered.

Such deposits should, on this hypothesis, be regarded quite simply as an integral part of the particular geological environment in which they occur - as a normal, though minor, sedimentary type developed, characteristically, in nearshore and shelf facies of intravolcanic units formed along the margins of eugeosynclines. They should not be considered - as, for example, is required by the replacement theory - as later features simply superimposed on a geological situation to which they are genetically unrelated. Where they are associated with folds and other structures, this may be attributed, from one instance to another, to mechanical migration during folding, weaknesses induced by preexisting sulfides, and, occasionally, to fortuitousness.

In the light of the postulated origin, it is suggested that the first stages in regional prospecting for deposits of this particular class should be broadly paleogeographical. Later phases of the search should then be directed to the delineation of sedimentary facies and, finally, to the investigation of geological structure.--Auth.

2-1822. Stanton, R. L. GENERAL FEATURES OF THE CONFORMABLE "PYRITIC" OREBODIES, PART II. MINERALOGY: Can. Mining & Metall.,

Bull., v. 53, no. 574, p. 66-74, 8 illus., Feb. 1960, 12 refs.

The second part of a 2-part paper [Pt. I, see abstract above] on the field association of the conformable "pyritic" deposits. It considers the more important features of their mineralogical constitution and their microtextures, reexamines the present interpretations of these, and offers some alternative explanations.

The term "pyritic" for these deposits is in many cases a misnomer, as 2 quite distinct ore types are involved. One is a banded pyritic sphalerite-galena-chalcopyrite ore (for which the term "pyritic" is indeed quite suitable), while the other is nonbanded and is composed essentially of pyrrhotite and chalcopyrite. In addition to these constitutional differences, each is distinctive in general appearance and texture.

The occurrence of 2 such consistent but clearly distinguishable ore types is attributed - rather than to difference in source material and pressure-temperature conditions of deposition - to the contribution of similar source material to dissimilarly oxygenated environments of sedimentation. Textures in the banded ores generally thought to be indicative of replacement or of high-temperature exsolution are explained by slow, low-temperature segregation in situ during compaction, folding, and regional metamorphism.--Auth.

2-1823. Hild, John H., and Charles K. Rose. EXPLORATION OF LEAD-ZINC DEPOSITS IN THE ROSS BASIN-LAKE COMO AREA, SAN JUAN COUNTY, COLO.: U.S. Bur. Mines, Rept. Inv. 5518, 50 p., 13 figs. incl. illus., 5 maps (2 in pocket), sections, tables, 1959, 4 refs.

A report on work done and results obtained in a minerals exploration program conducted by the U.S. Bureau of Mines in 1948, 1949, and 1950.

Four large veins - the Seven Thirty, Red Roger, Cashier-Shortstop-Canandaigua, and Queen Anne - and several narrow spur veins were explored at relatively shallow depths with core-drill holes. Thirty-nine holes, totaling 10,491.5 ft., were drilled, and the core samples were assayed at the Bureau of Mines station at Salt Lake City, Utah.

The veins, generally, contain small quantities of Au, Ag, Cu, Pb, and Zn in a gangue consisting principally of quartz. The metal content of the veins, in 24 holes was uniformly low.

In 15 holes, 18 core sections, 5 ft. or more long, had a higher base-metal or Ag content than contained in the bulk of the ores produced from San Juan County mines during the decade 1947-1956. The Au content in all sections but 2 was negligible.--Auth. summ.

2-1824. Heidenreich, W. L., and Burton Mark Reynolds. NICKEL-COBALT-IRON-BEARING DEPOSITS IN PUERTO RICO: U.S. Bur. Mines, Rept. Inv. 5532, 68 p., 28 figs. incl. illus., maps, sections, graphs, 13 tables, 1959.

This report describes the methods and results of field investigations conducted by the U.S. Bureau of Mines between Dec. 1956 and Dec. 1957 on 7 deposits of Ni-Co-Fe bearing laterite and weathered serpentine near the W. coast of Puerto Rico E. and S. of Mayaguez. These deposits were named, for purposes of identification, Guanajibo, Punta Guanajibo, Las Mesas, N. and S. deposits of the Rosario SE. group, and the W. and E. deposits of the Maricao SW. group.

MINERAL DEPOSITS

tion, the lower 17 mi. of the Guanajibo River was tested at widely spaced intervals for possible concentrations of magnetite and chromite in the alluvial sands.

The objective of the investigations was to appraise, by mapping and sampling, the 2 largest deposits - the Guanajibo and Las Mesas. Testing of the smaller deposits was much more restricted. Field investigation consisted of mapping, drilling with power auger, making drill-hole sections, and preparing samples for chemical analyses, mineralogical studies, and metallurgical tests. The work was financed jointly by a cooperative agreement by the Bureau of Mines and the Economic Development Administration, an agency of the Puerto Rican Commonwealth.

Drill-hole locations on the Guanajibo and Punta Guanajibo deposits conformed for the most part to a grid pattern of 800-ft. squares. Holes were spaced in the eastern part of Las Mesas deposit at 200-ft. intervals along N.-S. lines 800 ft. apart where topographic and other conditions permitted; elsewhere, the pattern of drilling was less regular because of the presence of improved estates and the rugged topography. The other 4 deposits were tested with a few drill holes at sites readily accessible to the surface; inferred tonnages and grades of Ni-enriched material in these deposits are indicative only. Drilling in the laterite-serpentine deposits totaled 16.5 ft. in 279 holes, from which 2,520 interval samples were taken. Drilling in the Guanajibo River valley totaled 310 ft. in 10 holes, from which 55 samples were taken. The inferred reserves of Ni-enriched laterite and weathered serpentine in the 7 deposits, based on a cutoff of 0.6% Ni, are 90.5 million tons, with an average Ni content of 0.88%. The average Co and Fe contents are 0.09 and 23.2%, respectively. The average thicknesses of the enriched zones range from 10.5 to 51, and the mean is 19.5 ft. The drilling in Guanajibo River valley did not disclose significant concentrations of magnetite and chromite.--Auth. introd. & summ.

25. Dale, Vernon B. **TUNGSTEN DEPOSITS OF YUMA, MARICOPA, PINAL, AND GRAHAM COUNTIES, ARIZ.: U.S. Bur. Mines, Rept. Inv. 5517, 68 p., 29 figs. incl. maps, plans, secs., 5 tables, 1959, 12 refs.**

This report describes briefly most of the known W deposits in Yuma, Maricopa, Pinal, and Graham counties, Arizona. Most of those described were examined by the author. Work was being done on only one property during the course of this investigation. Necessary annual assessment work had been completed on the majority of the properties during the past 3 years (July 1956-June 1958). Production figures are given for each deposit, where known, and for each county. Reserve estimates were made for the individual counties. All elevations are approximate, having been obtained by aneroid barometer.

The occurrence of W minerals is sporadic and discontinuous; hence, samples taken by conventional methods, other than bulk mining, are usually unreliable. The appendix contains a log of all assays made during this investigation. Most of the deposits examined contained shallow surface workings only. At least all of them the commercial W ores had been removed as they were found, leaving only marginal low-grade material exposed. Development work was found in only 3 areas, and they were not extensive.

The search for new occurrences of W minerals was greatly stimulated in this area by the U.S. Gov-

ernment purchasing program announced May 10, 1951, wherein the government agreed to purchase Standard-grade W concentrates at \$63 per short-ton unit. The program, with slight modifications, lasted until Dec. 1956. An investigation was made and a report written on all known W occurrences in Arizona in 1941. Yuma County had 1 known W occurrence in 1941, compared with the 26 described in this paper. On 19 of these properties W minerals were discovered after May 1951. Wilson described only 1 Maricopa County deposit compared with 6 described in this paper, 5 of which were discovered after May 1951. All W occurrences in Pinal County were discovered before May 1951. Field work for this report was done from Jan. to June 1958.--From auth. summ. & concl.

2-1826. Pattee, Eldon C. **TUNGSTEN RESOURCES OF MONTANA: DEPOSITS OF THE MOUNT TORREY BATHOLITH, BEAVERHEAD COUNTY: U.S. Bur. Mines, Rept. Inv. 5552, 41 p., 36 figs. incl. illus., maps, secs., 4 tables, 1960, 15 refs.**

The U.S. Bureau of Mines began an investigation of W resources of Montana in Sept. 1953. This report presents information obtained from July 1955 to Sept. 1957 on W deposits in and near the Mount Torrey batholith. The batholith comprises part of the Pioneer Mountains of Beaverhead County in the SW. corner of Montana.

Included in the report are assays and preliminary examination data on 22 properties. W minerals are known to occur in 19 of the properties. The major producer is the Brown's Lake mine which has produced more than 625,000 tons of ore.

Nearly all of the deposits are in the Lost Creek, Utopia, and Bald Mountain mining districts along the E. and S. margins of the Pioneer Mountains. The districts are less than 27 mi. from Dillon, Montana.

In general, the deposits can be divided into 2 types: contact metamorphic deposits and quartz-fissure-vein deposits. In one isolated occurrence, W minerals are intermixed with manganese oxides in mantle rock. The contact metamorphic deposits consist of tactite containing disseminated scheelite and powellite. These deposits generally are the most extensive; the average grade is less than 0.47% tungsten trioxide (WO_3). The largest deposit is about 4,470 ft. long and a maximum of 160 ft. wide; the W minerals occur sporadically. The quartz-fissure veins occur in the batholith or in small stocks nearby and are limited in size.

Small, irregular areas within the sparsely mineralized tactite zones may contain to 2% WO_3 , but they seldom can be mined separately because of their small size and irregular distribution.--Auth. summ. & introd.

2-1827. Dale, Vernon B., and William Alan McKinney. **TUNGSTEN DEPOSITS OF NEW MEXICO: U.S. Bur. Mines, Rept. Inv. 5517, 72 p., 29 figs. incl. maps, plans, secs., 9 tables, 1959, approx. 50 refs.**

A brief description of most of the known W deposits in New Mexico, based primarily on field examinations by the author.

Most of the properties visited contained small, sporadically mineralized, discontinuous ore deposits; however, at the Iron Mountain deposit in Sierra County and at the Cunningham Hill deposit (Ortiz Mine grant) in Santa Fe County there are low-grade deposits large enough to warrant a study of open-pit operations when the price of W is high. Virtually

all the deposits are in mountainous country, and, because most of the deposits are small, transportation and mining costs are high.

Past production of W ores in New Mexico was small. The total production is said to be 104 short tons of ore and concentrate (60% WO_3 basis) from 1900 to 1955, which is 0.06% of the national total.

At only one property were there any measured ore reserves - at the Cunningham Hill on the Ortiz Mine grant, Santa Fe County. From diamond- and churn-drill holes, surface trenches, and a few underground workings, about 3 million tons of ore, containing slightly less than 0.1% WO_3 , was estimated.

A few rock samples were taken in the field for laboratory identification. Where discussed in the text and followed by a sample number in parentheses, the detailed petrographic description can be found by referring to that number in the appendix. The appendix also contains a log of all assays made during this investigation.

Large samples were taken from the Cunningham Hill and the Iron Mountain deposits for metallurgical tests. The results of these tests are given.--From auth. summ. & introd.

2-1828. Mulligan, John J. TIN PLACER AND LODE INVESTIGATIONS, EAR MOUNTAIN AREA, SEWARD PENINSULA, ALASKA: U.S. Bur. Mines, Rept. Inv. 5493, 53 p., 12 maps and plans, 31 tables, 1959, 14 refs.

Ear Mountain is an isolated mountain mass that rises abruptly from the coastal plain on the NW. shore of the Seward Peninsula. Geologically it resembles the more accessible Brooks Mountain and Cape Mountain areas to the SW., being composed of a granitic core surrounded and partly capped by metamorphosed sediments. The occurrence of lode- and placer-Sn deposits in this area has been known since the early 1900's, when the Seward Peninsula region was prospected extensively for both Au and Sn.

The U.S. Bureau of Mines investigated the Sn deposits in the Ear Mountain area during the 1953 and 1954 field seasons. The objectives were to delimit the areas in which Sn minerals occur, as a guide to future prospecting, and to determine the amount of Sn in the known prospects. Work by the Bureau of Mines included both placer and lode sampling.

The Bureau placer-sampling program was essentially a reconnaissance to determine the distribution and relative abundance of placer Sn as a means of delimiting areas favorable to the discovery of the lode sources of the Sn minerals. A churn drill was used, and normal placer sampling and evaluation procedures were followed to determine the quantity and type of heavy minerals in the stream gravels. The data so obtained are roughly indicative of the quantity and type of heavy minerals in the rocks from which the gravels were derived. This indirect method of determining the extent of lode Sn was used because throughout the area outcrops are buried under a frozen mantle of detritus, peat, and tundra vegetation, varying in depth from a few inches to 40 ft. or more.

Bureau placer sampling showed minor to trace amounts of placer Sn in most streams that drain the granite and the granite-limestone contact zone on Ear Mountain. Cassiterite was identified in the gravels of Tuttle Creek, a nameless creek E. of Tuttle Creek, and in the Eldorado (all 3 forks), Crosby, Pinnacle, Step-Gulch, and Deer creeks in amounts of less than 0.05 to 0.2 lb. of Sn per cubic yard in mining sections up to 10 ft. thick. Radioactive min-

erals and valuable metals other than Sn were not found in greater than trace amounts.

Sections of Tuttle, Eldorado, and Kreuger creeks that were considered to be favorable for placer mining were drilled by the Alaska Tin Corp. under the provisions of a Defense Minerals Exploration Administration (DMEA) contract. On Tuttle Creek the "pay" gravels were found to average about 0.2 lb. Sn per cubic yard in the mining section; in the best hole 8 ft. of mining section contained 1.3 lbs. of Sn per cubic yard. On Kreuger and Eldorado creeks the pay gravels averaged about 0.3 lb. of Sn per cubic yard in the mining section; in the best hole 10 ft. of mining section contained 0.8 lb. of Sn per cubic yard. No significant quantities of other valuable minerals were found in the drill holes.

The Bureau lode-sampling program was confined to the areas drained by Tuttle and Eldorado creeks because the gravels of these streams contain substantially more Sn than the gravels of the streams sampled, and most of the lode prospects are in this area. Both Tuttle and Eldorado creeks head on the NE. slope of Ear Mountain. Float found in this area indicated that some cassiterite occurs as crystals and tiny veinlets in granite; however, it is associated more commonly with altered limestone adjacent to the granite-limestone contact. The few random crystals and scattered tiny veinlets of cassiterite that were found in granitic debris could not be traced to a source area. The cassiterite in altered limestone was found in an irregular zone extending along the granite contact from the E. side of North Hill to the W. side of Tuttle Creek, a distance of about 7,000 ft. The most mineralized float along this contact zone was from the vicinity of the Winfield shaft on North Hill, which was reopened. Bulldozer trenches were excavated along the contact E. and W. of the shaft, and additional samples were obtained from float at other old prospects.

The exposures in the Winfield shaft, and in trenches E. and W. of it, indicated that for about 1,000 ft. and an average width of 65 ft. the mineralized limestone adjacent to the granite contact contains 0.2% Sn and 0.3% Cu, with minor to trace amounts of Au, Ag, Pb, and Zn. Small zones within this area contain as high as 2% Sn, and others as high as 3% Cu; the higher grade zones apparently are due to local conditions that favored deposition; however, investigation did not eliminate the possibility that larger zones of similar grade may exist. In the areas sampled, much of the Sn occurs either as ungrained cassiterite that would be difficult to recover or as a component of minerals (such as paigeite) from which it would not be recoverable by the usual extraction processes. Analyses of selected specimens of float from the contact zone E. and W. of the area indicated that the mineralization is similar but may be somewhat lower in grade.

Exposures during this investigation were not adequate to establish the dip of the contact zone or the limits of mineralization. The granite-limestone contact apparently dips toward the N. but is highly irregular. Mineralization probably extends beyond the limits of sampling both along the contact zone outward into the limestone.

Radioactivity, varying from trace amounts to 0.01% equivalent U, was noted in a few samples from the Winfield shaft. The amount was too small to permit identification of the radioactive mineral or to determine the mode of occurrence.--Auth. summ.

2-1829. Mulligan, John J. SAMPLING STREAM GRAVELS FOR TIN, NEAR YORK, SEWARD PENINSULA, ALASKA: U.S. Bur. Mines, Rept. Inv. 5493, 53 p., 12 maps and plans, 31 tables, 1959, 14 refs.

A. ALASKA: U.S. Bur. Mines, Rept. Inv. 25 p., 5 maps, 14 tables, 1959, 18 refs.

In 1941 the U.S. Bureau of Mines has been conducting an intermittent program of placer and lode investigations to evaluate the potential Sn resources of the western Seward Peninsula Sn belt. Previous investigations were made in the Potato, Cape, Brooks (River), and Ear Mountain areas. As part of the program the Bureau made a reconnaissance of the Sn-bearing stream gravels in areas adjacent to the previously worked Sn deposits at Lost River and Potato Mountain. The objective of the reconnaissance was to determine if additional areas were favorable for lode or placer exploration. Work was begun in late fall 1956 and completed in the following summer.

Streams sampled were the Lost River and Tin Creek in the Brooks Mountain area and the Kik River and Kigezruk and Baituk creeks in the York area. Samples were obtained by churn-drilling and by employing conventional placer-evaluation techniques. Holes were drilled at wide intervals at the mouth of Tin Creek. Small amounts of Au were found on Baituk Creek and in one hole on the Kik River; the highest grade did not exceed 10 per cu. yd. Traces of scheelite and barite were found on York Creek, chromite was encountered in a hole on the Anikovik River, and minor amounts of minerals (probably derived from basaltic intrusions) were found in the York area.

The reconnaissance did not eliminate the possibility of valuable lode or placer deposits may be in the area, but the sampling data strongly indicate that the cassiterite and other heavy minerals in stream gravels are too widely and sparsely distributed to encourage further investigations except in the Lost River drainage basin, where substantial lode and placer deposits are known.--Auth. summ.

O. Harrer, Clarence Michael, and Willard Pesch, Jr. RECONNAISSANCE OF IRON OCCURRENCES IN COLORADO: U.S. Bur. Mines, Inf. 7918, 82 p., 22 figs. incl. illus., map, 27 refs., 1959, 81 refs.

This paper describes the location and general characteristics of Fe occurrences in Colorado. Most of the occurrences were examined; many are in forested and mountainous areas at altitudes of 5,000 to 13,700 ft. It is known to occur in 30 counties of western Colorado.

Transporting the ore to market is a handicapping economic factor involving long truck and railroad haulage. The nearest purchaser of smelting ores is the Colorado Fuel and Iron Corp., at Pueblo. When the ore can be sold locally for special purposes and at prices higher than can be obtained at Fe smelters, small-scale operations can supply that market. It was noted in many places in Colorado before 1900. Records of Fe-ore production are not complete, but available information indicates that a total of about 6 million tons was produced between 1870 and 1956. It was used for manufacturing Fe and Fe alloys, as heavy aggregate, for pitments, as a soil conditioner, and as flux in smelting nonferrous ores. It occurs as magnetite, hematite, and limonite in replacement-type contact-metamorphic deposits

in limestone associated with dioritic intrusives; as magmatic segregations of magnetite that is often titaniferous; as irregular bodies of iron carbonates oxidized to limonite and hematite; and as inorganic or biogenic precipitates in swamps and around Fe-charged springs.

The ore was mined by open-cut, simple gophering, open-stopping, room-and-pillar, and square-set-stopping methods.

A few old mines and undeveloped deposits still contain moderate reserves of Fe ore, and significant reserves might be developed in some known but inadequately explored deposits. Some deposits have high S, P, and Ti contents, and many will require beneficiation to make their ores marketable.

Because of the huge tonnages of Fe ore a modern steel industry requires, the Fe occurrences now known in Colorado are too small to be dependable sources of ore supply. Some deposits, however, will continue to be worked as special uses for their products encourage miners to exploit them.--Auth. summ.

2-1831. Brown, W. F. SAMPLING EAST TEXAS IRON ORES: U.S. Bur. Mines, Rept. Inv. 5488, 32 p., 18 figs. incl. illus., maps, secs., logs, 2 tables, 1959, 6 refs.

This report describes fieldwork of the U.S. Bureau of Mines during the fall of 1956 and spring of 1957 in obtaining samples of Fe ores of E. Texas. The E. Texas Fe-ore district comprises 2 contiguous areas known as the N. Basin and S. Basin.

In the N. Basin, Morris and Cass counties and parts of Upshur and Marion counties have commercial Fe-ore deposits. The important deposits of the S. Basin are in Cherokee, Anderson, and Henderson counties. This report is concerned principally with 4 deposits in Morris and Cass counties and presents the detailed results of drilling and sampling there.

The E. Texas Fe-ore deposits occur at the tops of ridges and hills in remnants of the Weches greensand formation of early Tertiary age. In the N. Basin, limonite and siderite ores occur as generally horizontal lenses and ledges or as irregularly distributed concretions in their respective greensand-clay-sand matrices. The thickness of the limonite zone exceeds 45 ft. in places but averages about 9 ft. The ratio of waste to ore is rarely more than 6:1. The siderite occurs below the water table and, where present, ranges in thickness from a few inches to 65 ft. The waste to ore ratio ranges from 3 1/2:1 to 10:1.

In the N. Basin, the operations of Lone Star Steel Co. are completely integrated - from mining crude limonite and siderite ores to manufacturing steel pipe. Sheffield Steel Corp. mines and mills limonite ores in both basins. All mining is done by open-pit methods; the overburden is removed with scrapers or bulldozers, and the ore is excavated with draglines. A combination of washers, screens, and classifiers beneficiates the crude ore.

Drilling and sampling by the U.S. Bureau of Mines supplied information on the occurrence and character of ores in selected deposits and provided samples for mineral dressing and metallurgical tests. Drilling on the 4 tracts totaled 2,145 ft. of 7 1/2-in. bore in 56 holes, 9 to 53 ft. deep. The gross weight of the cored ore sections was 57,280 lbs.--Auth. introd. & summ.

2-1832. Trengrove, Russell R. RECONNAISSANCE OF CALIFORNIA MANGANESE DEPOSITS: U.S. Bur.

Mines, Rept. Inv. 5579, 46 p., 4 maps, 4 flowsheets, 11 tables, 1960, 5 refs.

The purpose of this survey of Mn deposits was to determine the potential reserves of Mn in California. Where the reserves were large enough to be of interest, samples were taken for beneficiation tests to determine whether the Mn minerals were amenable to concentration. Gravity-concentration tests were made on Mn ores from several northern California deposits. Results of the tests indicated that the fine-grained texture of the Mn in the siliceous and cherty gangue made the ores unsuitable for gravity concentration. In some ores, very little Mn was liberated, even after grinding to minus-100-mesh.

This report presents information on the characteristics, location, and last-known owners of the more important deposits and gives results of U.S. Bureau of Mines metallurgical tests.

Most of the Mn produced in California has come from lenses of the oxide ore in the Franciscan formation of the Coast Range in the northern and central counties. The ore lenses parallel the bedding, which usually dips steeply but is sometimes more or less horizontal.

In southern California the low-grade ore (6 to 18% Mn) is amenable to concentration by gravity methods and can be upgraded to a marketable plus-40% Mn. All ore bodies are fissure-type deposits in andesitic conglomerates, lavas, or granite.

During 1940-1942 Bureau engineers examined over 150 Mn deposits, and 5 deposits were selected for exploration or extensive sampling. Large samples were taken from 18 properties for metallurgical tests.

Some information is available on more than 750 deposits, but at least two-thirds of the Mn occurrences have little or no importance. Production from 257 deposits totals 293,000 tons, which includes 10,000 tons from 14 deposits of unknown location. Production has been chiefly from deposits that were not explored systematically but were developed and mined simultaneously.

Future production can come only from low-grade manganiferous material that will require sorting or beneficiation to upgrade it to a marketable ore.--Auth. summ.

2-1833. Appling, Richard N., Jr. MANGANESE DEPOSITS OF NORTHEASTERN OREGON: U.S. Bur. Mines, Rept. Inv. 5472, 23 p., 7 illus., 7 maps, table, 1959, 8 refs.

This report presents information obtained by examination and investigation of manganese deposits in northeastern Oregon during May and June 1954 and Apr. 1957. Maps, assays, and other examination data are presented on 10 manganese deposits - 9 in Baker County and 1 in Grant County. Included among these deposits are all those that have undergone substantial exploration or have a record of production.

Seven of the Baker County deposits occur as characteristically small, irregular pods and lenses in argillite. The remaining Baker County prospects are primarily narrow, vein-type occurrences in schist. The Grant County occurrence is in greenstone and serpentine. All the deposits are composed of various manganese oxides, intermixed with abundant quartz and chert.--Auth. introd. & summ.

2-1834. Starratt, F. Weston. ALUMINUM - AFRICA'S METAL: Jour. Metals, v. 12, no. 5, p. 385-388, 2 illus., map, May 1960.

A combination of 2 factors points to a predicted

phenomenal expansion of Al production from Africa: one is a vast untapped potential of low-cost hydroelectric power and the second the continually mounting wealth of bauxite discoveries. Bauxite mining has been undertaken in Guinea since 1952 and in Cameroon since 1957. Various large-scale projects are under investigation in Guinea, Cameroon, Ghana, the Congo Republic, the Belgian Congo, and Angola. M. Russell.

2-1835. ALUMINUM IN AUSTRALIA: Jour. Metals, v. 12, no. 4, p. 338-339, map, Apr. 1960.

Discoveries of extensive deposits of bauxite on the coast of Cape York Peninsula, Queensland, have made Australia a potential major source of Al. Reserves here are estimated at 3 billion tons; an additional 2 million tons of metal-grade bauxite is estimated to be available throughout the country. A review of the potential market concludes that the domestic one is the most promising.--M. Russell.

2-1836. Kuster, William V. TITANIUM MINERALS IN THE HEAVY SAND DEPOSITS OF ASSATEAGUE ISLAND, MD.: U.S. Bur. Mines, Rept. Inv. 5512, 22 p., 3 maps, sec., 10 tables, 1959, 5 refs.

The investigation described in this report is part of a survey by the U.S. Bureau of Mines of the Ti resources of the United States. The purpose of this project was to study a typical coastal deposit of beach sands in the Middle Atlantic States, particularly in the area surrounding the Delmarva Peninsula.

The field investigation consisted of a reconnaissance survey of the Eastern Shore of Maryland, followed by surface sampling and drilling of the sands on Assateague Island, off the Atlantic coast of Maryland. The study covered the period Jan.-Dec. 1957. Detailed analyses were made of 5-ft. sections of 8 drill holes along the Maryland section of the island. The heavy-mineral fraction of these samples was separated by sink-float tests, using acetylene bromide as the heavy liquid. The minerals comprising the heavy fraction were examined microscopically, and mineral counts were made on selected samples.

Examination of the beach sands of Assateague Island indicated that these sands contain about 1.65% heavy minerals. The heavy-mineral content of 5-sections from 8 drill holes varied from 0.2 to 9.7%; 40% of the samples contained less than 1%. The average for each hole ranged from 1.17 to 3.08% heavy minerals. Samples from the surface may contain exceptionally large proportions of ilmenite, rutile, and other heavy minerals because of concentration by tide and wind. Such occurrences are too sparse to be important economically.

The heavy-mineral fractions of these sands contained quartz feldspar, ilmenite, rutile, zircon, and small quantities of garnet, xenotime, hornblende, chlorite, etc. The proportion of quartz and feldspar was usually more than 80%. Mineral counts of selected samples showed that ilmenite and rutile comprised 4 to 12% of the heavy-mineral fraction; the proportion of ilmenite to rutile ranged between 90:1 and 100:1.

It is concluded that the area of this assignment did not warrant further investigation during this survey.--Auth. summ. & concl.

2-1837. Hahn, Abner D., and Morris M. Fine. EXAMINATION OF ILMENITE-BEARING SANDS IN

MINERAL DEPOSITS

OTTER CREEK VALLEY, KIOWA AND TILLMAN COUNTIES, OKLA.: U.S. Bur. Mines, Rept. Inv. 577 p., 24 figs. incl. illus., maps, logs, 9 refs., 1960, 3 refs.

This report describes and gives the results of an investigation by the U.S. Bureau of Mines of ilmenite-bearing placer sand deposits in the 24-mi. long valley of Otter Creek, Kiowa and Tillman counties, Oklahoma. Drilling and sampling was completed in periods between Oct. 1956 and Sept. 1957. Mineralogical studies and mineral-dressing tests on recovered ilmenite and other heavy minerals from composite samples of the sands were made in Bureau of Mines laboratories at Rolla, Missouri, in 1957 and early 1958.

Otter Creek rises in and drains the southwestern flank of the Wichita Mountains, which are reported locally by knolls and ridges of gabbro and are surrounded by plains floored with flat-lying sandstone and red beds. The valley fill consists of a sand-clay component, derived from weathering of igneous rocks, and an overlying silt-clay alluvium. Ilmenite is present in significant quantity in the sand-clay component, but only in the basal sand-

stone deposits were sampled by drilling 330 holes, aggregating 13,025 ft. of bore, and taking 1,218 samples of cuttings from the holes. Results of the sampling indicate that the ilmenite-bearing basal component of the alluvial fill on 6,980 acres in 2 deposits covers an area of 14.5 mi. of the valley has an average thickness of 24.8 ft. The silt-clay overburden averages 9.4 ft. thick.

The sand-clay material in the basal component is estimated to be approximately 374 million short dry tons containing 1.24% of titanium dioxide (TiO_2).

On the results of mineral-dressing tests made by the Bureau of Mines on samples of this material, recoverable ilmenite concentrates having an average grade of 45.4% TiO_2 and containing small quantities of Fe, Ni, Cr, and V, are estimated to be 7,729,000 tons. The Cr content of the concentrates obtained in laboratory tests on composite samples of the basal component was considerably higher than the average reported for commercial concentrates.

The basal component in the S. 9.5 mi. of the valley has a low TiO_2 content (average, 0.20%) and was included in the estimate of potential resources. Hematite (FeTiO_3) is the major Ti-bearing mineral assumed in the Ti-pigment industry and may be important as a raw material in the production of titanium metal.--Auth, introd. & summ.

8. Schreck, Albert E., and Joseph C. Arundson. STRONTIUM, A MATERIALS SURVEY: U.S. Bur. Mines, Inf. Circ. 7933, 45 p., 3 illus., 2 flowsheets, 16 tables, 1959, 54 refs.

Celestine (strontium sulfate) and strontianite (strontium carbonate) are the principal Sr minerals. The use of its more widespread occurrence, celestine, is important commercially.

The most important use for Sr minerals is as the raw material for manufacturing Sr compounds, the bulk of the Sr consumed is in the form of Sr compounds.

Sr compounds (primarily the nitrate, oxalate, and carbonate) have important uses in the defense program including tracer bullets, distress signals, and other types of signal and warning flares used in military services. In addition, Sr compounds are used in fireworks, railroad and highway warning devices, welding-rod coatings and zinc refining.

Sr minerals occur in many states, but the principal domestic deposits are in Texas, California, Arizona, and Washington. Domestic production is small and erratic. The major portion of the Sr consumption is supplied by imports from Great Britain and Mexico.

The domestic reserve of Sr minerals is large when compared to current consumption, but markets for the minerals are small, and in most areas the cost of preparing the mineral for market and transporting it to the principal consumers discourages competition with the imported material from Great Britain and Mexico. Sr minerals are expected to continue to come from foreign sources.

Sr minerals usually are mined by conventional open-pit methods and beneficiated by hand picking or simple gravity concentration. They are converted to Sr chemicals by either the soda ash or the calcining process, the former yielding strontium carbonate and the latter strontium sulfide. Other Sr salts can be made by treating the carbonate or sulfide solutions with the acid of the desired salt.

The leading producers of Sr minerals are the United Kingdom, Mexico, and Germany. The first commercial production of strontianite was in 1840, from the deposits in Westphalia, Germany, and the English deposits came into production in 1875. Mexico did not become an active producer until 1941.

Because of the many uses for Sr compounds by the military forces and because of the small and erratic domestic mineral production, Sr minerals are considered to be strategic and critical materials to be acquired for the national stockpile. Adequate information must therefore be available to defense planning agencies for determining stockpile objectives and defense needs during times of national emergency. This report attempts to assemble available data on this commodity.--From auth. introd. & summ.

2-1839. Earl, Kenneth M. JOHN BURDETTE BARITE-FLUORITE DEPOSIT, GARRARD COUNTY, KY.: U.S. Bur. Mines, Rept. Inv. 5480, 14 p., 2 maps, 4 secs., 2 tables, 1959, 2 refs.

The purpose of this investigation was to obtain subsurface information on this deposit in Garrard County, Kentucky.

The deposit was intersected in each of 5 inclined diamond-drill holes aggregating 1,163 ft. All holes were drilled from the hanging wall of the deposit; the inclinations varied from minus 41° to minus 75°. Disseminated metallic sulfides were noted in the drill cores from holes 1, 2, 4, and 5. The deepest drilling was hole 5, which intersected the deposit at approximately 490 ft. down dip.

Visual inspection of the cores did not indicate mineralization of economic importance; therefore, no chemical analyses were conducted. Condensed logs of diamond-drill cores are included in this report. All drill cores were shipped to the U.S. Bureau of Mines core library in Minneapolis, Minnesota for future reference.--Auth. summ.

2-1840. Bates, Robert L. GEOLOGY OF THE INDUSTRIAL ROCKS AND MINERALS: 441 p., geol. maps, secs., diag., graphs, tables, New York, Harper & Brothers, 1960, refs.

This book attempts to deal rather thoroughly with the geology and economic use of all those relatively neglected, but highly important, natural resources which are ordinarily not classed as either fuels or metals.

It is divided into 11 chapters, grouped into 3 major parts. Pt. 1 includes the brief introduction, which stresses the all-too-little-realized importance of the subjects at hand, and Chap. 2, which is concerned with "classification." In the latter are listed the 13 industrial rocks and 20 industrial minerals which are treated in the text.

Pt. 2 includes Chaps. 3-6. Of these Chaps. 3 and 4 are concerned respectively with igneous and metamorphic rocks. Those in the former category have an annual value in excess of \$150,000,000. They include not only such common structural materials as granite, but also less well known materials such as pumice, with its growing modern use as concrete aggregate. Slate and marble - each with a raw-state value in excess of \$10,000,000 a year - are discussed in Chap. 4. Two chapters on the sedimentary rocks follow, including sand, gravel, sandstone, clay, limestone, dolomite, phosphate rock, gypsum, and salt.

Pt. 3 includes Chaps. 7-11 and treats of "igneous minerals" such as feldspar, mica, and the lithium minerals; "vein and replacement minerals" such as quartz, fluor spar, barite, and magnesite; "metamorphic minerals," such as graphite, asbestos, talc, and vermiculite; "sedimentary minerals and sulfur," including alluvial diamonds, diatomite, potash and sodium minerals, borates, and nitrates; and "minor industrial minerals" such as cryolite, garnet, pyrophyllite, and tripoli.--From introd. by C. Croneis.

2-1841. Badollet, Marion S., and N. W. Edgerton. PROPERTIES OF ASBESTOS FIBERS IMPORTED INTO THE UNITED STATES: Can. Mining & Metall. Bull., v. 53, no. 573, p. 12-17, 3 diag., 6 tables, Jan. 1960.

A study of the physical properties of long grades of asbestos fibers imported into the United States during the past 8 years has disclosed information that will contribute materially to effective selection and use of fibers for electrical products. The study embraced fiber lengths, volume resistivity under 3 different conditions, total Fe by chemical analysis, magnetic rating, conductivity of an aqueous extract and its sodium chloride equivalent.

The fibers examined included chrysotiles from Rhodesia, British Columbia, and Barberton area [Africa]; marlme from Bechuanaland and Quebec; amosite and crocidolites from Africa and Australia; and anthophyllites from Mozambique and from Georgia in the United States.

Volume resistivity values provide a relative basis for estimating the electrical performance of end products, magnetic rating - an estimate of the quantity of Fe compounds present in excess of those in the asbestos structure, conductivity of an aqueous extract, and an estimate of the ionizable impurities in fibers.

Tests of these factors yield information, not heretofore generally known, which may serve as a guide in the evaluation of asbestos fibers for electrical products.--Auth.

2-1842. Wiebelt, Frank Joseph, and M. Clair Smith. A RECONNAISSANCE OF ASBESTOS DEPOSITS IN THE SERPENTINE BELT OF NORTHERN CALIFORNIA: U.S. Bur. Mines, Inf. Circ. 7860, 52 p., 21 figs. incl. maps, plans, secs., 4 tables, 1959, 31 refs.

Production of small tonnages of asbestos has been reported from 18 California counties; 16 additional counties have occurrences of asbestos. The counties

in the northern part of California that have had a recorded production are: Alameda, Amador, Calaveras, Contra Costa, El Dorado, Napa, Nevada, Placer, Shasta, Siskiyou, Trinity, and Tuolumne. No deposit in the state has maintained consistent production.

Serpentinized peridotites (potential chrysotile-bearing rocks) are widely distributed in the coast ranges, Klamath Mountains, and western foothills of the Sierra Nevada.

Occurrences of chrysotile and amphibole asbestos of fair quality have been known in California for many years, but industry has been slow to explore them thoroughly. Of those occurrences that have been prospected or worked, none has shown a sufficient reserve of good-quality chrysotile asbestos for it to be classed as commercially important. The concentrations of chrysotile asbestos seldom exceed 5%, the grade above which deposits are considered to have commercial interest.

Small quantities of asbestos have been produced and sold intermittently in California since 1882, but the first year of recorded production was 1887. The year of peak value and of peak output was 1955.

Some chrysotile deposits in northern California, specifically in Calaveras, Napa, Nevada, Shasta, Siskiyou, and Tuolumne counties, are of fair size, and indications are that a considerable output of chrysotile fiber might be obtained from them, should suitable exploration and development work be done.

Amphibole asbestos deposits in Shasta and Placer counties await development of an expanded market for tremolite and anthophyllite asbestos.--Auth. sur

2-1843. Branner, George Casper. SULFUR IN CALIFORNIA AND NEVADA: U.S. Bur. Mines, Inf. Circ. 7898, 50 p., 2 maps, 4 graphs, 12 tables, 1959, 24 refs.

S as referred to in this study includes both elemental and combined S. The S may be chemically combined, as in iron sulfide, hydrogen sulfide, sulfur dioxide, or sulfuric acid.

The sources of S in California and Nevada are: 1) native S (S ore); 2) pyrite; 3) oil-refinery gases, from which hydrogen sulfide or elemental S is recovered; 4) smelter gases, from which sulfur dioxide is recovered.

For the 52-year period, 1906-1957, California and Nevada have produced about 3,546,000 long tons of valued at \$58,328,000. More than 99% of this S, by quantity and value, has originated in California.

Although 8 known deposits or groups of deposits of native S in California and 2 in Nevada appear to have commercial possibilities, only one deposit has been operated on a substantial scale. This is now being worked as the Leviathan mine of the Anaconda Company, Alpine County, California. Ore from this mine is trucked to a plant near Yerington, Nevada, for making sulfuric acid.

Only one pyrite mine, the Hornet mine of The Mountain Copper Co. of California, Shasta County, has produced consistently.

Total production in California of oil-refinery elemental S or "brimstone" and hydrogen sulfide, in terms of S content, is now slightly greater than that of S from native S and pyrite. Production, in terms of S content, from oil-refinery gases has grown from about 15,000 long tons in 1948 to about 149,000 long tons in 1957. Initial recovery from petroleum sources in 1937 was due primarily to efforts to reduce air pollution, but as the technology of recovering hydrogen sulfide and elemental S from refinery

ases improved the practice has become of increasing economic importance in refinery operation. Today, recovery usually would be continued irrespective of the existence or nonexistence of air-pollution problems. At present no oil refineries are operating in Nevada.

Relatively little liquid sulfur dioxide and sulfuric acid are recovered from smelter gases in California, and none is recovered in Nevada. It does not appear likely that recovery from this source will increase substantially.

Data on reserves of native S are meager, and substantial exploratory work remains to be done both in California and Nevada before a significant over-all estimate can be made of reserves.

Pyrite reserves of the Hornet mine, in Shasta County, California, are believed to be sufficient to permit shipments at present levels for at least 10 years. A reserve of sulfide fines, principally pyrite, approximately 13,200,000 short tons exists in Kennecott Copper Corp., Nevada Mines Division, mill-tailings dump at McGill, Nevada. This reserve is not being exploited, because no economic means for its use has yet been devised.

Basically the possibility of expanding S production in California and Nevada depends on the substitution of locally produced S for imported S. At present, net imports (all interstate) are estimated to be about 6,000 long tons annually of Gulf Coast (and occasionally Wyoming) S, or about one-third the total estimated consumption. S recovered from refinery hydrogen sulfide may, in a few years, supply 17,000 long tons of this amount. The balance (about 78,000 long tons) would have to come from increased cracking capacity of refineries, S ore, or pyrite, or be imported from other states. Whether or not this much ore or pyrite can be produced in California depends upon: 1) determining the economic reserves of known S ore deposits and occurrences now regarded as potentially competitive, and 2) relating a producing to a S-consuming industry in such a way as to make the delivered price of local S competitive. An example of the latter is the relation between S-ore production at the Leviathan mine and its consumption near Yerington, Nevada.

Developing a new source of pyrite does not appear encouraging, but economic means may be found to utilize the large reserve of pyrite in the tailings dump of the Kennecott Copper Corp., Nevada Mines Division, smelter at McGill, Nevada.--Auth. summ.

1844. Van Sant, Joel N. REFRACTORY-CLAY DEPOSITS OF COLORADO: U.S. Bur. Mines, Rept. Inv. 5553, 156 p., 53 figs. incl. illus., maps, plans, sec., 15 tables, 1960, 46 refs.

This report describes the occurrence, mining, and use of refractory clay in Colorado. Field work by the U.S. Bureau of Mines included examination of active and abandoned refractory-clay mines as well as a reconnaissance survey and sampling of numerous clay-bearing formations exposed in Colorado.

Most of the refractory clay mined in the Denver-Golden district of Colorado is not used for refractory purposes but is blended with other clays in the manufacture of structural clay products. The predominantly flint-clay deposits in the Pueblo and Fremont County districts are mined and utilized chiefly in fabricating refractory products.

Underground mining methods are employed to extract the clay. Shrinkage-stope methods are used in the steeply dipping deposits of the Denver-Golden district, and modified room-and-pillar methods are

used in the relatively flat-bedded deposits in Pueblo and Fremont counties. Mining practice ranges from hand methods to semimechanized, the latter commonly being adopted when the mine workings become extensive. The larger mines usually are owned or leased by clay-products manufacturers.

Most of the easily accessible refractory-clay deposits in the Denver-Golden district have been exploited. However, about 1,500,000 tons of high-grade refractory material in the Dakota-Purgatoire formations [Cretaceous] S. of Kassler, Jefferson County, can be extracted through inclined shafts or long crosscut adits. Another 1,500,000 tons probably can be mined from existing and lower levels in the mines in the Dakota formation between Coal Creek and Kassler. In the Wilson Creek area of Fremont County reserves of 200,000 tons of refractory flint clay have been indicated by drilling. The reserves of the Turkey Creek and Rock Creek districts of Pueblo County are estimated at 3,870,000 and 850,000 tons, respectively, of refractory clay composed of about equal parts of plastic and flint clays.

During the Bureau's field investigation numerous outcrops of high-grade refractory material were discovered throughout the state. Character samples of this refractory material were taken, but these scattered samples do not provide enough information to evaluate reserves. Reflecting the eastward change in facies of the clay in the Dakota-Purgatoire formations, the refractoriness decreases toward the eastern part of the state, where the clays generally become more ferruginous and contain an increasing amount of fluxing impurities.

The 3 most promising areas in the western part of the state for prospecting high-grade refractory clay are: 1) the vicinity of Gunnison, Gunnison County; 2) E. of Delta, Delta County; and 3) the Dakota formation W. of Ridgway, Ouray County.

The thick-bedded clay deposits easily accessible from the outcrops eventually will be depleted. Higher exploration, development, and mining costs will result. Improved mining methods and complete mechanization of the mines will keep the rise in cost at a minimum. Although improved methods and mechanization will not necessarily provide clay at a lower cost, they will assure a supply of refractory material for many years. All types of clay required by the refractory-clay industry in Colorado cannot be supplied from one district, but they usually can be obtained from other refractory-clay-producing districts within the state.

Because the pyrometric cone equivalent (P.C.E.) of the plastic clay occurring in the Dry Creek Canyon member of the Dakota formation varies considerably and often falls below the high-grade category, search for a consistently high P.C.E. plastic clay, which has been carried on by the refractory-clay-products manufacturers in the Canon City district, should be and undoubtedly will be continued.

The regional lack of diaspore and other high-alumina clays for upgrading (sweetening) available refractory clays inhibits the manufacture of superduty refractories in Colorado. Consequently, a research project directed to the use of available high-alumina material, such as the topaz derived as a by-product from milling molybdenite ores at Climax, Lake County, might be desirable.

Further exploration, coupled with beneficiation research, of the high-refractory plastic-clay deposit partly prospected S. of Trinidad, Las Animas County, should increase the reserves of high P.C.E. bonding clay. The additional cost of beneficiation might be warranted considering the relatively small proportion

of bonding clay needed in refractory production.--
From auth. summ.

2-1845. Sahinen, Uuna M., R.I. Smith, and D.C. Lawson. PROGRESS REPORT ON CLAYS OF MONTANA: Montana Bur. Mines & Geology, Bull. 13, 83 p., 2 secs., 7 tables, 1960, 4 refs.

This report is the second on a survey of Montana's clay and shale resources. The first progress report was issued in June 1958 as Information Circular 23. The survey, started in 1956, catalogs the clay and shale deposits of the state. Likely deposits are sampled and the clays examined for possible use as ceramic raw materials, as possible sources of expanded shale lightweight concrete aggregate, and as possible sources of alumina for the production of metallic Al. In the report, 155 samples are described from 120 different localities, mainly in central and eastern Montana. Ceramic data, X-ray data, expansion data, and chemical analyses are tabulated. Of the 155 samples examined, 54 were suitable for common ceramic ware, 47 were suitable for expanding into lightweight aggregate. Of the 45 samples containing over 20% total alumina, only 6 showed an acid-soluble alumina content of over 15%.--U.M. Sahinen.

2-1846. Williamson, D.R., and Lorraine Burgin. LIMESTONE OCCURRENCES IN COLORADO: Colorado School Mines, Mineral Industries Bull., v. 3, no. 1, p. 1-12, 4 maps, correlation chart, Jan. 1960, 40 refs.

Availability of good, cheap limestone greatly aids industrial development in any area because it is the raw material for a great many important products. In the building trades it is essential for making cement, plaster and mortar. It has so many volume uses in chemical and other industrial processes it has become known as "the king of all bases." Many of the uses affect the defense program. Many soils are conditioned by addition of lime, either in crude or processed form; Ca and Mg have uses as metal, and the crude rock is a good road metal or concrete aggregate. Limestone formations often are good oil and gas reservoirs, and they are vast stores of evidence about the earth's history, the knowledge of which is important in many fields. Greater knowledge about limestone occurrences is becoming increasingly important in every area for industry and for many unrelated arts and sciences.

Limestone deposits in Colorado are of marine and fresh-water origin and range in age from Cambrian to Cretaceous. Formations containing limestone in Colorado are listed, with brief notes as to lithology and stratigraphic correlation of each.--From intro.

2-1847. Hartley, Robert P. SAND DREDGING AREAS IN LAKE ERIE: Ohio, Div. Shore Erosion, Tech. Rept. no. 5, 79 p., 10 illus., 13 maps (4 in pocket), chart, sec., 4 diags., 12 graphs, 10 logs. 5 tables, Jan. 1960, 7 refs.

Studies of the 4 commercially exploited sand and gravel deposits in the Ohio waters of Lake Erie - Maumee Bay, Cedar Point, Lorain-Vermilion, and Fairport - were made during the period 1953-1957. The areas and amounts of sand and gravel were determined by mapping and sampling methods from a research boat equipped for profiling with echo-sounders, for sampling with a surface snapper sampler and jetting pipe, and for horizontal control by sextant. Com-

mercial aspects of the deposits are described including grain size, sorting, composition, and rounding. Each area is discussed in detail by reference to a map and includes a description of the bottom features. A description of the samples taken is given and shown by graphs of size vs. sorting. Results of mechanical analyses are given by table and the boring logs made for each area are shown. A description of quality and composition of sand as related to commercial usage is included, and an estimate of the amounts available is made as follows: Maumee Bay - 3,000,000 cu. yds.; Cedar Point - 17,037,000 cu. yd.; Lorain-Vermilion - 120,000,000 cu. yd.; Fairport - 52,852,000 cu. yd. The potential and present uses of the material are discussed in detail.

The Maumee Bay deposit is apparently a result of longshore drift from the SE., forming a baymouth bar. The source area for the materials is the till SE. or lakeward of the deposit. The Cedar Point deposit has been created apparently by longshore sand movement, primarily from the SE. The Lorain-Vermilion deposit is probably the remnant of a frontal moraine deposited during the second stage of glacial Lake Maumee and has since been modified and reworked by wave and currents. The Fairport deposit origin is more complicated, but is related to wave and current action during lower lake levels - the sand is well-sorted in the medium sizes.--J.R. Hyland.

2-1848. Alberta, L. pt. of Mines and Minerals. ANNUAL REPORT OF THE MINES DIVISION. . . 1959: 86 p., map, tables, Edmonton, Queen's Printer, 1960.

The 1959 output of coal from the mines in Alberta was 2,549,517 tons from 71 subsurface and strip mines employing 1,720 men. Production of shale, clay, limestone, and building stone was 1,818,157 tons from 24 quarries. This annual report includes statistical data on disposition of products, mechanization of the mines, accidents, examinations for licensed positions, timber and explosives used in mining, reports of analysis of coal samples, and lists of mines and quarries.--M. Russell.

2-1849. Godfrey, John D. NORTHEAST CORNER OF ALBERTA AND ADJACENT AREA: ITS DEVELOPMENT AND MINERAL POTENTIAL: Can. Mining & Metall. Bull., v. 53, no. 576, p. 250-259, illus., 2 maps, Apr. 1960, 35 refs.

A brief account of economic developments in and around northeastern Alberta is presented, and mention is made of mining and industrial developments currently of interest in the area. Planned and projected operations are briefly discussed for this region. The history of geological surveys and mining activities in the Shield area of Alberta and the adjoining parts of Northwest Territories and Saskatchewan is traced. Reassessment of the presently-known economic picture of northwestern Canada in conjunction with some recent information on Precambrian structures of northeastern Alberta points to some interesting mining possibilities, particularly in and around that province.--Auth.

2-1850. Brown, W.L., R.C. Bray, and Mine Staff. THE GEOLOGY OF THE GECO MINE: Can. Mining & Metall. Bull., v. 53, no. 573, p. 3-11, 4 maps, 5 secs., 2 tables, Jan. 1960, 5 refs.

The property of Geco Mines Ltd. is located near

Manitouwadge Lake, E. Thunder Bay district of NW. Ontario approximately 160 mi. E. of Port Arthur. The ore body is of outstanding interest because of its occurrence in a terrane of high-grade metamorphic rocks. It is a continuous zone in quartz muscovite schist (once a granular quartzite) with a horizontal length of nearly 2,400 ft. and an average width of about 65 ft., containing about 15 million tons averaging 1.76% Cu, 3.75% Zn, 1.74 oz. Ag, and 13% pyrite per ton. The ore zone is associated with a series of dykes which have been intruded by basic sills, pegmatite dikes, and granite. A large S-shaped drag fold related to the major Manitowadge syncline, plunges E. at 35° and controls the bottom or W. end of the ore zone. Several post-ore diabase dikes interrupt the ore zone, which is also offset by the Fox Creek cross fault. A core of massive sulfides (pyrite 20%, pyrrhotite 20%, sphalerite 14%, chalcopyrite 6%, and galena and marcasite less than 1%) has been replaced by a breccia formed by a main strike fault in the gneisses, and is surrounded by an envelope of disseminated sulfides. The deposit is of hydrothermal replacement origin.--P. R. Eakins.

1851. Geoffroy, P. R., and T. Koulomzine. MOGADOR SULPHIDE DEPOSIT (VENDOME MINES LIMITED): Can. Mining & Metall. Bull., v. 53, no. 16, p. 268-274, 3 illus., 4 maps, 4 secs., Apr. 1960.

The discovery of the Mogador deposit [30 mi. N. Val d'Or, Quebec] concealed by 100 ft. of overburden was the result of combined application of geological reasoning, ground geophysical surveys, studies of glacial float, and extensive diamond drilling. The ground was acquired because it lay on the projected intersection of the Manville and Laflamme river faults. Systematic ground prospecting led to discovery of mineralized floats. A first unsuccessful exploration campaign lasted several years and consisted of 137 drill holes.

In 1951 the boulder nests were reexamined, and an association of the mineralized float with boulders of a granodiorite, unknown in outcrops of the district, was established. Consequently, ground magnetic surveys were extended and reinterpreted, and a large anomaly interpreted as corresponding to a batholith was outlined. The existence of the batholith was immediately confirmed by drilling and the Mogador deposit discovered in third hole of new drilling program in a zone of fractured volcanics paralleling southern contact of batholith.

The Mogador deposit is a complex replacement of silicified volcanics by pyrite, pyrrhotite, sphalerite, chalcopyrite, and galena carrying values in Ag and Au. A total of 1,230,000 tons has been indicated, most of it now classified as fully developed proven ore.--Auth.

1852. Cooper, John R. SOME GEOLOGIC FEATURES OF THE PIMA MINING DISTRICT, PIMA COUNTY, ARIZONA: U. S. Geol. Survey, Bull. 112-C, p. 63-103, 3 illus., 2 maps (col. geol. map pocket, scale 1:31,680), 9 diags. (8 on pl. in pocket), 5 tables, 1960, 38 refs.

Rocks ranging in age from Precambrian to Recent crop out in the Pima district. Granite, which locally contains many large inclusions of schist and hornfels, is believed to be Precambrian, as it appears to be overlain unconformably by the Bolsa quartzite of Middle Cambrian age. Probably all the Paleozoic formations of the region are represented, but only

the Bolsa quartzite, at the base of the Paleozoic section, has been differentiated on the geologic map. Overlying the Paleozoic rocks is a complex of sedimentary and volcanic rocks assigned to the Cretaceous(?). Sedimentary units include conglomerate, arkose, graywacke, quartzite, shale, and a few thin beds of limestone. Volcanic units include andesitic and rhyolitic types. The stratigraphic sequence within the Cretaceous(?) complex is not known. Preliminary subdivisions based on lithology are shown on the map.

Diorite, andesite, granodiorite, and quartz monzonite porphyry postdate the Cretaceous(?) complex and are assigned to the Late Cretaceous or early Tertiary. These rocks, with the possible exception of some of the diorite and andesite, were intruded after a major orogeny that affected the Cretaceous(?) complex. They are all mineralized locally. The quartz monzonite porphyry, which is probably the youngest of these rocks, is associated in space with several large Cu deposits, suggesting that porphyry and ore are related genetically.

In one part of the district, folded and faulted Cretaceous(?) rocks are unconformably overlain by a welded rhyolitic tuff. It is not clear whether the tuff is older or younger than the ore.

A deformed postmineralization formation, here named the Helmet fanglomerate, overlies the rhyolitic tuff unconformably. The fanglomerate consists predominantly of coarse, ill-sorted and ill-bedded conglomerate characterized by angular pebbles, cobbles, and boulders in an abundant silty matrix. Intercalated are lava flows of porphyritic andesite, scarce thin beds of rhyolitic tuff and tuffaceous sediments, and lentils and tongues of monolithologic breccia which appear to have been emplaced as landslides. Several stratigraphic units are indicated by variations in color, composition of fragments, sedimentation features, and presence or absence of tuffaceous material. The formation is probably at least 10,000 ft. thick. It is believed to be made up of alluvial-fan deposits derived from the W., SW., or NW. No fossils have been found, but tentative correlations suggest that the fanglomerate may be of early Miocene age.

Andesite dikes cut the Helmet fanglomerate, and Quaternary alluvial deposits cover much of the central and eastern part of the area described.

The structural relations of the Helmet fanglomerate indicate 2 orogenies that postdate the Cretaceous(?) rocks. The earlier, pregranodiorite and premineralization, resulted in complex fold and fault structures that trend NW. The later, postmineralization and post-Helmet, resulted in a large thrust fault and steep tilting to the SE. Rotational effects of the post-Helmet orogeny must be removed to restore the structure at the time of mineralization.

The San Xavier thrust fault beneath the northeastern part of the district cuts the Helmet fanglomerate and is therefore a postmineralization thrust. Small faults in boulders of the fanglomerate in the thrust plate suggest that the plate moved NNW. Similarities in the geology of the plate and of the autochthonous block to the S. suggest that the plate moved about 6 1/2 mi. NNW.--Auth.

2-1853. Crowley, Frank A. DIRECTORY OF KNOWN MINING ENTERPRISES, 1959: Montana Bur. Mines & Geology, Bull. 14, 68 p., 1960.

This report contains a list of the mining properties known to be active in Montana in 1959, giving the name, operator, owner, status, product, and loca-

tion of each property. It also contains a list of active coal mines in Montana in 1959, submitted by Thomas Morgan, State Coal Mine Inspector.--Auth.

2-1854. Holland, Charles T. MINING IN SOUTH-WEST VIRGINIA, 1950-1960: Mineral Industries Jour., v. 7, no. 1, p. 5-6, map, 2 tables, March 1960, ref.

The mining industries of this part of Virginia are estimated to have produced about \$1.4 billion worth of materials in 1950-1960, more than 3/4 of the mineral production of the state during this period. The most important of the products are briefly described: coal, stone, lime, Pb and Zn, salt, cement, Mn.

clay, natural gas, pyrite-pyrrhotite, gypsum. Other materials produced include petroleum, Ag, iron oxide, clays, feldspar, "aplite," mica, and Ti. During the past few years considerable investigation of low-grade mineral deposits has been underway. By the end of the 1960's, the state's yearly mineral production may reach \$1 1/2 billion.--A.C. Sangree.

2-1855. Korzhinskaya, K.N. THE STRUCTURE OF THE MINE FIELD OF THE SLYUDYANKA PHLOGOPITE DEPOSIT: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 6, p. 57-68, 7 figs. incl. map, secs., pub. Apr. 1960, 6 refs.

English translation of GeoScience Abstracts 1-269.

13. FUELS

See also: Areal and Regional Geology 2-1665; Geophysics 2-1717, 2-1722, 2-1725; Geochemistry 2-1745; Sedimentary Petrology 2-1785; Mineral Deposits 2-1848, 2-1853.

2-1856. Pyle, Howard C. A PHILOSOPHY FOR EXPLORATION: Jour. Petroleum Technology, v. 12, no. 5, p. 17-19, May 1960.

The success of an exploration program is largely dependent upon the effectiveness of exploration teams. Putting the teams together is not enough. They must work with skill and with enthusiasm, and every facility must be provided for the continued and uninterrupted search for oil. Vast resources of money, equipment, and manpower [are] used during time of war. Similarly, the money, equipment, and manpower of an exploration company should all be directed toward keeping its exploration teams effectively at work.--From auth. summ.

2-1857. Hiestand, Thomas C. APPLICATION OF GEOLOGY IN COMPUTING DEPLETION OF PRODUCING PROPERTIES: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 4, p. 409-422, 3 charts, 2 diags., Apr. 1960, 10 refs.

Discussion of depletion depends upon 2 initial assumptions: 1) privately owned property (land) is the basic capital asset in economy of the United States, and 2) a property (tract of land) extends geologically from superficially surveyed boundaries to a point at the center of the earth as a prism containing rocks, minerals, and fluids which are natural resources and which are measured in acre-feet.

By definition, the depletion of a property is reduction in sales value equal to value of minerals, rocks, and fluids produced and sold from the premises, daily and annually. Depletion involves producers possessing oil and gas which are produced and sold from a lease property and including Royalty Interest (Lessor) owner, Working Interest and Overriding Royalty Interest (Lessee) owners.

Depletion of a typical lease property is illustrated by taking into account its entire recovery of oil and gas (100,000 barrels of crude sold at stock tanks for \$277,000) and by establishing what the crude is worth on a market to a willing buyer and willing seller at reservoir level the instant crude enters well bore (\$92,000). On the producers' books the accountant figures depletion as 33 1/3% of crude price per barrel recorded on sales receipts for the typical lease property per day or per year.

Recoverable oil and gas estimates are fundamental

in establishing operators' assets and liabilities, and present worth. During economic life of lease property, qualitative (geologic) conditions always divide into 6 critical stages and events in operating: quantitative (engineering) conditions cannot be extrapolated from one stage to the other. Properly such estimates are stated, stage by stage, in 3 amounts, maximum, probable, and minimum. Accordingly these estimates are not widely in accounting for depletion of a property when self-assessing tax on oil and gas produced and sold during each taxable year.

When geologic principles and concepts are dovetailed with the economic conditions prevailing, depletion can be computed for all properties, including all minerals, rocks, and fluids produced and sold from the premises. Annual reduction in sales value of property, when self-assessing tax, is expressed commonly as a percentage of the price recorded in sales receipts per property per year. Statutory amendment by Congress in 1926 established temporary percentage provisions for oil and gas inasmuch as figures were arbitrary in compromise between Senate and House. Proper percentage provisions can be established by the geologic-economic method of computing value; therefore, proper depletion should be authorized by Congress and the President to enable the Treasury Dept. to accept tax on the amounts of oil and gas sales receipts per property which will not be confiscation of private property (capital assets).--Auth.

2-1858. McCray, Arthur W., and Frank W. Cole. OIL WELL DRILLING TECHNOLOGY: 494 p., 213 figs. incl. illus., maps, charts, secs., diags., graphs, 34 tables, Norman, University of Oklahoma Press, 1959, refs.

This textbook is basically appropriate for advanced students. It covers all phases of oil well drilling, rotary and cable tool, mud, gas, and air. Exhaustive coverage includes mathematical derivations of appropriate formulae and theory and practice of all aspects of drilling, drilling equipment, miscellaneous down hole operations, and economics.

Chap. 1 is a short introduction describing the origin, size, and importance of the industry. Chaps. 2 and 3 briefly describe the geology of oil occurrence and the use of geophysical methods in oil finding. Chap. 4, "Acquisition of Leases," traces land law, gives a basic oil and gas lease, and tells of the variations.

Chaps. 5 and 6 are concerned with certain prob-

were associated with smaller quantities of clays found to be in the mica or illite group. None of the cores appeared to contain clays of the kaolinite group. In the lower section of the J.V. sandstone indications of what appeared to be the mineral sepiolite were noted.

When the liquid-permeability measurements were obtained, it was noticed that some cores swelled so much that their cementing material was ruptured, the structure of the sandstones was broken, and the core was literally pushed outward from the material in which it was mounted for the permeability measurements. The greatest swelling occurred in fresh water.

The results of these tests indicate damage to the flow capacity of the reservoir rocks caused by water reacting with the clays in the formation. Therefore the results suggest the advisability of using a non-aqueous drilling fluid, such as oil or dry gas, to prevent swelling of the clays. The results of the study show that other California reservoir rocks may be expected to contain swelling clays because of their proximity to the source of these materials. These fields should be studied to ascertain their susceptibility to damage by water. As a part of this study, the clay minerals native to these formations should be identified, and their influence on the productivity of wells in the field should be evaluated.

Differential thermal analysis results and optical methods showed that the clays in the oil-reservoir rocks were not free of oil, even though they had been extracted with toluene. Because enough organic material remained on the clay to burn and affect the thermogram, the differential thermal analyses of the core samples were determined in a nonoxidizing atmosphere of N.

Reservoir rocks are an accumulation of materials deposited under water. Consequently, contaminants are common in an oil sand. The mineral composition and minerals associated with these "oil sands" have not been studied to any extent. The behavior of certain minerals associated with an oil-reservoir rock, such as the cementation materials composing perhaps no more than 2 or 3% of the whole body, may control the physical character so critically that little or no oil may be recovered from the rock. Certain clay types prevail among these minerals in many California oil sands.--Auth. introd. & summ.

2-1862. U.S. SANDSTONE POOLS ARE ANALYZED: *Petroleum Week*, v. 10, no. 19, p. 23-24, map, 3 graphs, May 13, 1960.

A survey of more than 7,000 reservoir sandstones in the United States provides many clues as to where and how oil and gas may be found. The survey, made by the American Association of Petroleum Geologists, covering about 15% of all U.S. fields, provides a broad outline of the composite geologic and geometric characteristics of reservoir sandstones. Some general guides for oil finding can be drawn from the study. The fields studied have an average of 4.4 pools each, but the big majority of fields have only one pool. Tertiary sandstones are by far the most common. Thick reservoir sandstones, though fewer in number, contain more large accumulations of petroleum. Structural traps control petroleum accumulation in a majority of all reservoir sandstones. Although sand bars form the most common kind of stratigraphic trap among pools of all sizes, beaches or strandline deposits account for the greatest percentage of large stratigraphic pools. Large stratigraphic traps are more likely to contain gas than oil

or mixed fluids.--From auth.

2-1863. Reeves, Corwin C., Jr. HOW OIL CAME TO BE: *Compass*, v. 37, no. 3, p. 213-219, March 1960.

The numerous theories which have been expounded to explain the origin of oil are reviewed. They fall generally into 2 classes depending on the primary source material, organic or inorganic. One even calls for a cosmic origin. It is concluded that a satisfactory and conclusive answer does not exist. The most feasible source material is marine organic matter whose transformation is brought about by a series of chemical reactions which though common to the sedimentary sequence are probably assisted by any of the innumerable catalysts found in the marine environment.--M. Russell.

2-1864. Cate, Robert B., Jr. CAN PETROLEUM BE OF PEDOGENIC ORIGIN?: *Am. Assoc. Petroleum Geologists, Bull.*, v. 44, no. 4, p. 423-432, Apr. 1960, 97 refs.

Many soils provide conditions similar to the marine reducing environment considered essential for petroleum genesis. C isotope ratios indicate that petroleum may be derived from nonmarine organic matter. This paper presents the hypothesis that podzolization (the joint downward movement of organic matter, metals, and clay through the weathering profile) may involve the catalytic transformation of some of the organic matter to bituminous substances. Somewhat similar materials do occur in soils, and soil organic matter does move downward through the profile. There is much evidence and opinion for the concept that many metal deposits, especially laterites, are formed in part by podzolization, possibly with the concomitant formation of bitumens. Organic podzolizing agents appear to be derived mainly from leaf exudates and decomposing leaves, as well as from root and bacterial exudates and decomposition. The active agents from leaves are apparently primarily acidic polysaccharides and polyphenols, and may include amino acids, simple sugars, and enzymes with a porphyrin structure. Soils commonly contain large amounts of acid-type catalysts, especially Fe and Al ions. In the presence of such catalysts, carbohydrates can undergo reactions which might lead to the formation of hydrocarbons. The various bituminous materials found in nature seem to form a continuum which includes petroleum, oil shale, and bituminous coal. This continuum is a logical corollary of the pedogenic hypothesis. The common association of oil with other bituminous substances, coupled with evidence of downward migration, provides some geological basis for considering this problem from the pedogenic point of view. If the preceding ideas are reasonable, further "geopedological" research might be justified, similar to that done by Proshliakov on V movement in the oxidized zone of an oil-bearing limestone. The oil fields of northeastern Brazil might be a logical site for study, in view of the widespread occurrence there of massive laterite, underlain by a variety of "bitumens," some of which seem to have migrated downward.--Auth.

2-1865. HUGE NEW GAS PROVINCE IS SHAPING UP: *Petroleum Week*, v. 10, no. 14, p. 39-40, 2 illus., map, Apr. 8, 1960.

Northeastern British Columbia Middle Devonian

gas discoveries during the last 6 months show tremendous potential. Absolute open flow on 4 of the discoveries have been 135, 185, 500 (approximate) and 825 million cu. ft. per day. The first discovery was brought in by Western Natural Gas Company, Inc. near Fort Nelson only last winter. A gas pipeline will be extended into this area, possibly by next year, and is certain to touch off even greater efforts next winter.--C.C. McFall.

2-1866. Gallup, W.B. CURRENT EXPLORATORY TECHNIQUES IN THE ATHABASCA BITUMINOUS SANDS AREA: Can. Mining & Metall. Bull., v. 53, no. 576, p. 245-249, 4 illus., 2 maps, secs., table, Apr. 1960.

The Athabasca bituminous sands [Alberta] have been subject to sporadic investigations since the beginning of the century. It is probable, however, that much of what has been learned and achieved concerning the deposit has been accomplished in the last few years.

Current exploratory techniques, generally speaking, involve a moderate amount of coring. Electrologs and often radioactive logs are run on most holes, and certain types of these achieved excellent qualitative analysis when backed up by some core analysis for calibration. Exploration is moving back from the river, and consequently a permanent network of access roads has been developed within the last few years. Most of the operations take place in the winter. There are about 90 permit holders at present.

Some exploratory techniques are set up to go into recovery experiments where rich tar beds are found. It is probable that in the final analysis there will be several successful methods of extraction and that both mining and various *in situ* techniques will be applicable depending upon the problem locally.--Auth.

2-1867. Clark, K.A. PERMEABILITIES OF THE ATHABASCA OIL SANDS: Can. Mining & Metall. Bull., v. 53, no. 576, p. 239-244, illus., 9 diag., 4 tables, Apr. 1960.

The repacked mineral aggregates of good grade oil sands have permeabilities ranging from 15 darcys to 350 millidarcys. The variation is due to the silt contents of the aggregates. Few good grade oil sands contain as much as 30% silt; most of them contain less than 20%, and a large proportion have less than 10%.

The permeabilities of repacked good grade oil sands (oil included) depend on the degree of liquid saturation. When saturation with oil plus water reaches between 80-90%, permeability is reduced to zero. As total saturation decreased below 80%, permeability increases rapidly. Permeabilities of between 1 and 2 darcys were observed for total saturations between 60-70%.

The mean value for 18 measurements of the permeabilities of "undisturbed" core samples of good grade oil sands was 50 millidarcys. This value is probably too high. The mean value for 20 measurements on core samples of interbedded oil sand and shale was 100 millidarcys. The mean value for 11 measurements on shale was 10 millidarcys.--Auth.

2-1868. Round, G.F. THE SHEAR STRENGTH OF McMURRAY OIL SANDS: Can. Mining & Metall. Bull., v. 53, no. 576, p. 233-238, 7 diag., 7 tables, Apr. 1960, 10 refs.

In order to obtain values of angle of shearing resistance and initial resistance for McMurray oil sand for use in general design calculations, the shear strength of this oil sand was measured in a controlled strain type tester, modified so that the rate of deformation could be varied between 0.01725 and 0.1869 in. per min. Effect of temperature was investigated by adapting the equipment to operate at both 71° and 185°F. The data are reported in terms of angle of shearing resistance and initial resistance for varying rates of deformation, composition, and temperature. While the main sets of results reported here were obtained at a bulk density range of 108.7-109.5 lb./cu. ft., some results were obtained at a bulk density range of 101-102 lb./cu. ft. Analysis of variance tables have been drawn up from the results obtained from least squares correlations and significance tests applied. It was concluded that oil content and temperature were significant variables for the degree of shear strength developed by the oil sand; increase of oil content and decrease of temperature each cause an increase in shear strength. The bulk density range 108.7 to 109.5 lb./cu. ft. gave angles of shearing resistance from 30° to 40° and initial resistance values of 0.37 p.s.i. to 0.85 p.s.i. For the bulk density range 101 to 102 lb./cu. ft., lower values of shear strength were obtained, indicating that compaction density was also of importance.--Auth.

2-1869. Smith, Harry Nelson, J.W. Smith, and W.C. Kommes. PETROGRAPHIC EXAMINATION AND CHEMICAL ANALYSES FOR SEVERAL FOREIGN OIL SHALES: U.S. Bur. Mines, Rept. Inv. 5504, 34 p., 14 illus., 7 tables, 1959, 28 refs.

As a basis for the oil shale investigations to be undertaken in this country, the progress of foreign countries in developing and using oil shale as a source of liquid fuels was studied by the technical missions of the U.S. Bureau of Mines. Oil shale mines, retorting plants, and refineries were visited, geological information on the nature and occurrence of the foreign oil shales was obtained, and samples of the oil shales were collected where possible.

Samples collected by these missions or acquired by other means came from Australia, Brazil, Canada, France, Manchuria (China), New Zealand, Scotland, Spain, Sweden, Thailand, and Union of South Africa. These countries represent a large part of the locations where oil shale developments have taken place. The major omissions are the Estonian, German, and Russian developments.

To produce comparable results the samples of oil shale from the above countries were analyzed by the same methods. The data consist of petrographic examination, X-ray analysis, assay by the modified Fischer retort method, chemical analysis of the oil shales and their assay products, oxide analysis of the shale ashes, and mass spectrometric analysis of some of the assay gases. Similar data are presented for a composite sample representing the 73-ft. Mahogany zone in the U.S. Bureau of Mines oil shale mine near Rifle, Colorado.

The information given here provides data necessary for comparing these selected oil shales of world-wide interest and evaluating the applicability of their respective processing methods to other oil shales. The grades and amounts of oil shale and shale oil are expressed in U.S. gallons of 231 cu. in., barrels of 42 U.S. gallons, and U.S. short tons of 2,000 lbs.

Selected parts of the data have been published previously in the Bureau of Mines reports of investi-

gations on the technical missions. Data on the composite sample from the Mahogany zone and samples from which it was prepared have been published in a previous Bureau of Mines report.--Auth. introd. & summ.

2-1870. Lyon, J.R. A RESERVOIR STUDY OF THE JUMPING POUND FIELD: Can. Mining & Metall. Bull., v. 53, no. 573, p. 35-39, map, 2 secs., 5 graphs, 2 tables, Jan. 1960, ref.

A brief review of the history and geology of this gas field situated 22 mi. W. of Calgary, Alberta, and a discussion of the reservoir performance to the present is presented. The maximum capacity of the field and plant is rated at 90 MMc. f. per day of raw gas. The recoverable reserves are estimated to be 600 billion cu. ft. of new gas. The field is behaving like a normal depletion-type reservoir.--P. R. Eakins.

2-1871. Chetin, A.K., and W. W. Fitkin. GEOLOGY OF THE WEYBURN FIELD, SASKATCHEWAN: Can. Mining & Metall. Bull., v. 52, no. 572, p. 751-761, 12 illus., 9 maps, 4 secs., Dec. 1959, 8 refs.

The reservoirs of Mississippian Midale beds and Frobisher beds found in the Weyburn field lie at the northwestern termination of a broad productive belt extending 120 mi. along the northeastern rim of the Williston basin. These carbonates, and interbedded evaporites, originated during cycles of marine transgression and regression, and were deposited as rock types characteristic of shoal, lagoon, and basinward shelf environments.

The Frobisher-Alida beds, which form a secondary reservoir to the main Midale beds of producing zone are composed of oölitic, fragmental-bioclastic, vugular limestone capped by an impervious dolomitic mudstone. Production is controlled by localized structural features resulting from depositional build-up. Excellent reservoir conditions are accompanied by an active water drive.

The Frobisher evaporite, consisting of massive primary anhydrite with dolomitic veinlets, forms the floor seal for the Midale beds oil accumulation. A significant facies transition into an oölitic, bioclastic, vugular limestone characterizes this unit. Beyond the depositional margin of the evaporitic facies, marked increases in porosity and permeability of the entire reservoir are noted. Carbonate units overlying the areal extent of the Frobisher evaporite exhibit a greater degree of metasomatism, dolomitization, and more abundant secondary anhydrite.

Porous carbonates composing the producing zone of the Midale beds are divided into an oölitic, fragmental-bioclastic, vugular limestone and an overlying granular marly limestone unit, capped by the Midale evaporite. Oil is accumulated in a stratigraphic trap bounded above and below by primary anhydrite and truncated by the post-Mississippian erosional surface. Mississippian strata dip basinward from this exosional surface in a broad homocline exhibiting only minor irregularities. Rapid lateral and vertical porosity and permeability variations are common. Localized, separated, porous lenticles contain interstitial water in areas where the Midale beds are underlain by the Frobisher evaporite. The major portion of the field, however, is capable of water-free production. Bottom and edge waters are found in certain portions of the field.

Productive limits are tentatively defined around most of the present field perimeter. A large area along the southern edge of the field remains open to future development. Probable ultimate remaining

recoverable crude oil reserves, as of Sept. 30th, 1958, were estimated by McDaniel Consultants Ltd. to be in excess of 330 million barrels.--Auth.

2-1872. Perry, Eugene S. OIL AND GAS IN MONTANA: Montana Bur. Mines & Geology, Bull. 15, 86 p., 2 pls., 23 figs., 4 tables, 1960, 76 refs.

Montana has been self-supporting in her needs for oil and gas for many years, and the present reserves are far from being depleted. Large areas still remain to be tested. Although not one of the major oil- and gas-producing states, Montana in 1959 produced 29,857,226 barrels of oil and 31,740,260 cu. ft. of natural gas. Oil has been produced from 66 different fields as delineated by the State Oil and Gas Conservation Commission. Gas has been produced from 20 fields. The fields are widely scattered in the plains area of Montana E. of the Rocky Mountains.

This report gives a brief history of oil development in Montana. The general geology and stratigraphy of central and eastern Montana are covered, and occurrence of oil and gas is described. Principal reservoir rocks are sandstone and limestone (or dolomite). Oil and gas have accumulated in anticlinal or domal structures, but the largest deposits occur in stratigraphic traps caused by lensing in sandstones, by decrease of porosity in sandstone, or by local development of porosity in limestone (or dolomite). Producing depths range from 400 ft. (gas) near Havre to 12,600 ft. (oil) in the Brorson field near Sidney. Descriptions of individual fields comprise the greater part of the report.--Auth.

2-1873. OPERATORS FOCUS ON ABO REEF TREND: Petroleum Week, v. 10, no. 17, p. 25-26, map, Apr. 29, 1960.

An expanding trend play is shaping up in Eddy and Lea counties, SE. New Mexico. Production along the trend, which stretches more than 50 mi. across both counties, is from an Abo barrier reef in the basal Permian. Stratigraphy apparently plays the major role in determining where oil is entrapped along the trend, although structural considerations cannot be overlooked. Reserve estimates for proved portions of the reef trend are good. Most of the activity along the trend is on the W. end of the Empire pool area of Eddy County.--M. Russell.

2-1874. Rinehart Oil News Company. IRA RINEHART'S REFERENCE BOOK ON THE McALESTER-ARKANSAS VALLEY BASIN. Compiled and Edited by R. P. Brooks, Jr.: 229 p., 9 illus. (2 fold.), 94 maps (2 fold.), 2 charts, 5 secs. (4 fold.), 69 logs, Dallas, Texas, 1959, 10 refs.

This attempts a comprehensive presentation of historical well data on 130 oil and gas fields and a forecast of future prospects in the McAlester-Arkansas Valley basin, comprising 19 counties of eastern Oklahoma and western Arkansas. Information is given on discoveries, producing zones, number of wells drilled, deepest tests, and formation records of all fields within the basin limits. Background articles are included on various geological aspects, drilling practices, and future prospects. These are:

Prospects for Finding Much Additional Gas Plus Oil Production in Basin Promising, p. 11-16.

Better Completion Techniques, Improved Drilling Methods Are Big Factors in New Basin Interest, p. 17-19.

ouser, Charles W. Arkansas Valley, With its
erous Geological Problems and Riddles, is "Land
portunity," p. 21-22.

asin's Real Prospects Will Unfold as More Wells
Scheduled to Check Deeper Formations in Area,
3-30.

umerous Structural Features Already Mapped in
ansas Valley but Well Control Lacking, p. 31-33.
asin Seen As Good Gas Reserve Despite Present
t of Adequate Pipeline Outlet, Low Gas Price,
5-36.--M. Russell.

75. Riggs, Calvin Harold, J. L. Eakin, and
Johnston. PETROLEUM-ENGINEERING
DY OF MUSKOGEE OILFIELD, MUSKOGEE
NTY, OKLA.: U.S. Bur. Mines, Rept. Inv.
3, 40 p., 15 figs. incl. maps, graphs, logs, 7
es, 1959, 4 refs.

The Muskogee field, one of the oldest oil-produc-
areas in Oklahoma, yields paraffin-base oil of 40°
gravity - a gravity higher than that of most Okla-
a oils. Oil was discovered in the townsite of
Muskogee in 1894 but was not produced in commer-
quantities until 1904. A peak yearly rate of
40,000 barrels of oil was attained in 1910.

Although oil has been produced from several hori-
es in the Muskogee field, 94% of the cumulative
covery of oil was from the Muskogee and Timber
ge sands of the Dutcher series. Approximately
0 wells have been drilled in the field and approxi-
ely 9,679,000 barrels of oil has been recovered
in the Dutcher sands underlying 4,436 oil-produc-
acres in the field. Many barren streaks in the
d represent areas where oil-bearing sands are
ent or nonproductive. Much of the field was
andoned during periods of low crude-oil prices,
some of these abandoned areas were later re-
iled and are now (1957) oil-productive. Water-
ding is being applied on a 240-acre property in
western part of the field. Preliminary results
cate that this secondary-recovery method should
duce additional oil.

In making this study of the Muskogee oilfield the
ters used all driller, electric, and gamma-ray
s available in company and government offices.
U.S. Bureau of Mines gamma-ray logging equip-
nt was used to log 22 additional wells in the field.
lyses of cores from 5 wells and samples of drill
ings from 4 other wells were studied and com-
ed. Samples of oil and water produced from most
he 83 active oil wells in the field were analyzed
studied. These data and the available oil pro-
tion records permitted engineers to interpret
ditions of the sand and to estimate the secondary-
covery potentials of the field.

Absence of an adequate water drive and evidence
gravity drainage indicate that much oil has not
n recovered from many parts of the Muskogee
d. Results of laboratory tests on oil samples
X-ray examination of clay minerals in the oil
ds show that the Muskogee and Timber Ridge
ds are susceptible to waterflooding. This is sub-
stantiated by the preliminary results of waterflood-
a lease in the western part of the field. Oil pro-
tion from the flood increased from 173 barrels
May 1956 to 1,830 barrels in Oct. 1957. Air and
injection, applied with moderate success in a
areas, indicates the possibility of recovering
ditional oil by this method.

This study showed that approximately 850 acres
the Muskogee and Timber Ridge sands in the
Muskogee field are favorable for waterflood develop-

ment. A larger area should profit from systematic
injection of air or gas.--Auth. introd. & summ.

2- 1876. Texas Petroleum Research Committee.
PROCEEDINGS, TWELFTH OIL RECOVERY CON-
FERENCE. A SYMPOSIUM ON THE OIL INDUSTRY
OF SOUTHWEST TEXAS...OCTOBER 29-30-31,
1959: Its: Bull. 80, [130] p., 13 maps, chart, 6 pro-
files, 10 secs., 27 diag., 19 graphs, 15 logs, 16
tables, Corpus Christi, Oct. 1959, approx. 70 refs.

This symposium was co-sponsored by the South-
west Section, Society of Petroleum Engineering,
American Institute of Mining, Metallurgical, and Pe-
troleum Engineers, and the Texas Petroleum Re-
search Committee.

The oil- and gas-producing provenance of SW.
Texas includes a gross area of 32,373,800 acres or
about 24% of the state's total land area. The petro-
leum geology of SW. Texas is diverse and interest-
ing. Stratigraphic conditions are complex and sedi-
ments are thick. Ordovician, Cretaceous, Eocene,
and Miocene strata are productive.

The great variety of conditions and the vastness
of the area provide every kind of problem known to
the oil industry. The single most important problem
confronting the operators and petroleum engineers
of the region is that of obtaining maximum ultimate
recovery from the known oil fields. Conventional
methods of primary and secondary recovery will
result in eventual production of some 2 billion barrels
more oil, and if no new fields are found at least
twice this amount will remain unrecovered in the
presently known oil fields unless improved methods
of recovery are devised. The objective of this oil
recovery conference is to focus attention on the vital
facts of the petroleum industry of the region.--From
introd. by G. H. Fancher.

The 14 papers included in this symposium are
listed below in the order in which they appear.

Kirby, J. E., Jr., R. C. Culver, and J. B. Mattei.
Profitable Application of Well Logs, paper no.
1303-G, 6 p.

Bell, John S. Engineer's Oil, A Challenge and
an Opportunity, paper no. 1385-G, 5 p.

McClain, O. G. Geology of Southwest Texas,
paper no. 1386-G, 12 p.

Decker, Harold. Proration and Well Spacing in
Texas, paper no. 1387-G, 7 p.

Storer, T. C., and J. B. Plaza. Some Economic
Aspects of Pressure Maintenance Operations as Illus-
trated by the History of Three Secondary Recovery
Projects, paper no. 1388-G, 13 p.

Landrum, Bobby L., James E. Smith, and Paul B.
Crawford. Calculation of Crude Oil Recoveries by
Steam Injection, paper no. 1389-G, 12 p.

Baugh, E. G. Performance of Seeligson Zone 20-G
Enriched Gas Drive Project, paper no. 1390-G, 8 p.

Craig, F. F., Jr., and W. W. Owens. Miscible
Slug Flooding - A Review, paper no. 1391-G, 10 p.

Leissner, E. L. Comparison of Waterflood Pat-
terns in Thin South Texas Reservoirs, paper no.
1392-G, 12 p.

Cameron, John S., Jr. A General Discussion of
Gas Proration in Texas, paper no. 1393-G, 8 p.

Staples, D. R., and F. S. Haines. Injectivity Pro-
file Logging and its Applications, paper no. 1394-F,
8 p.

Crosby, George E., and Robert J. Cochran. Per-
formance of an Alternate Repressuring and Produc-
ing Project, paper no. 1395-G, 8 p.

Caudle, B. H., and I. G. Loncaric. Oil Recovery
in Five-Spot Pilot Floods, paper no. 1396-G, 8 p.

Flanagan, D. A., and Paul B. Crawford. Feasibility of Underground Storage of Liquid Methane, paper no. 1397-G, 11 p.

2-1877. EAST TEXAS JURASSIC PLAY EXPANDS: *Petroleum Week*, v. 10, no. 15, p. 22, map, Apr. 15, 1960.

A Smackover lime discovery in eastern Delta County has broadened the fast growing Jurassic play in East Texas. The discovery is the first Jurassic producer outside the Mexico-Talco fault system. Production has been gauged at 5 million cu. ft. per day of gas plus 7 barrels of condensate per million. The gas, unlike that from other Smackover producers, has no hydrogen sulfide. The discovery was made by drilling an abandoned shallow hole.--M. Russell.

2-1878. Adair, John K., Jr. EAST TEXAS OIL FIELD, GREGG, RUSK, UPSHUR, SMITH, AND CHEROKEE COUNTIES, TEXAS: *Compass*, v. 37, no. 3, p. 174-181, graph, table, March 1960, 19 refs.

The East Texas oil field is a monoclinical structure located on the W. flank of the Sabine uplift producing from the Upper Cretaceous Woodbine sand at an average depth of 3,600 ft. Discovery was in 1930. The field covers 140,000 producing acres and is the largest oil field in the United States in terms of: number of producing wells, productive acreage, number of oil operators, total volume of oil produced, magnitude of oil reserves, amount of salt-water production and volume of salt water returned to the reservoir.--M. Russell.

2-1879. Bornhauser, Max. DEPOSITIONAL AND STRUCTURAL HISTORY OF NORTHWEST HARTBURG FIELD, NEWTON COUNTY, TEXAS: *Am. Assoc. Petroleum Geologists, Bull.*, v. 44, no. 4, p. 458-470, 8 maps, 6 secs., Apr. 1960, 10 refs.

The Northwest Hartburg field, located in southern Newton County, is in a structural belt which forms part of the Gulf Coast Frio (Oligocene-Miocene) producing trend and for which the name Hartburg flexure is suggested.

The various structural and depositional features (folds, faults, truncation, channels, etc.) observed in this trend are particularly well exhibited in the Northwest Hartburg field area and indicate a structural development which, reaching a climax during earlier Frio time, can be divided into 4 stages.

Stage 1. During stage 1, continental shelf conditions prevailed throughout the area, and a sedimentary series, consisting essentially of shale in its lower and a sandy section in its upper part, was deposited on the slowly subsiding shelf. The sand section is subdivided, in ascending order, into the Nodosaria sand, and lower and upper Hartburg sands, the latter 2 names replacing the more commonly used but misleading names "lower and upper Hackberry sands."

Stage 2. Toward the end of upper Hartburg sand sedimentation, the area experienced a large scale and semiregional structural disturbance in the form of a breakdown of a segment of the Gulf Coast geosynclinal floor. This event tilted the continental shelf, producing the Hartburg flexure (scarp) and an embayment which was later filled by the Hackberry shale.

Stage 3. The tilting of the continental shelf area induced gravity flow in the sedimentary beds which

was essentially a downfolding process. The resulting synclinal folds formed deep troughs and trenches, turning the scarp into one of considerable relief that resembled the topography of the present continental slope of the northwestern Gulf of Mexico. Most of the troughs show effects of local submarine erosion in the form of channels and scour scars, some of which extended also across the anticlinal fold adjoining the trough. Besides tilting the continental shelf the regional downwarp also lowered the base level of erosion and depositions across the shelf area. In adjustment to the new profile of equilibrium the anticlinal folds were truncated as evidenced by the presence of a local angular unconformity between the Hackberry shale and underlying formations.

Stage 4. After gravity flow subsided and the new base level of erosion was attained, turbidity current and sedimentary flows filled the troughs and channels with "channel-fill" deposits.

On completion of the peneplaning action, the deposition of the Hackberry shale commenced restoring again to the area more normal depositional conditions. Mild folding and faulting continued or were rejuvenated during this and later depositional cycles on some of the local folds in the Hartburg trend.--Auth.

2-1880. SOUTHWESTERN WYOMING PACES ROCKIES: *Petroleum Week*, v. 10, no. 15, p. 19-22, map, Apr. 15, 1960.

The SW. corner of Wyoming is one of the most promising oil and gas areas in the Rocky Mountain region. Sweetwater County is the focal point of activity in the Green River basin. Today's major activity in the county grows from relatively new awareness of the potential of the Upper Cretaceous Montana group, usually referred to as Mesaverde. While several gas discoveries in the Mesaverde were made in various sections of the county during the last few years, real interest was not generated until oil was found in the Almond late in 1959. Significant gas discoveries are still being made. Most of the recent oil and gas discoveries are in the Desert Springs-Table Rock area, but there have been successes in other parts of the county.--M. Russell.

2-1881. Shotts, Reynold Q. COAL RESERVE ESTIMATES ON A REGIONAL BASIS: *Alabama Acad. Sci., Jour.*, v. 31, no. 3, p. 201-219, 3 maps, Jan. 1960, 10 refs.

Coal reserves should be classified on the basis of rank of coal, grade of coal, thickness of beds, thickness of overburden, and weight of coal. Reserves should be classified as follows: measured reserves, indicated reserves, and inferred reserves. Rules are suggested for outlining areas of measures, indicated, and inferred coal in the southern Appalachian region. Suggested procedure for working out a regional reserve estimate and an example using hypothetical data are given.--M. Russell.

2-1882. Ginzburg, A.I. CLASSIFICATION AND NOMENCLATURE OF THE MICROCOMPONENTS OF COAL: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.* in translation, 1958, no. 6, p. 73-78, 2 tables, published Apr. 1960, 5 refs.

English translation of GeoScience Abstracts 1-27

2-1883. Shterenberg, L.E. CERTAIN FACTORS AFFECTING THE DEVELOPMENT OF PSEUDO-STRUCTURES IN THE DONETS BASIN COAL: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.* in translation, 1958, no. 6, p. 73-78, 2 tables, published Apr. 1960, 5 refs.

SSSR, Izvestiya, Geol. Ser., in translation, no. 4, p. 48-54, 5 illus., pub. Feb. 1960, 9

pseudostructures in coals are revealed in microscopic study, under crossed nicols. They do not belong to the material of the components and may be present in all components of coal.

14. ENGINEERING GEOLOGY

Also: Geomorphology 2-1671; Fuels 2-1868.

2-1884. Johnson, Gerald W. NUCLEAR EXPLOSIONS IN SCIENCE AND TECHNOLOGY: Bull. Atomic Scientists, v. 16, no. 5, p. 155-161, 5 diags., May 1960.

The Plowshare program will determine industrial scientific uses of nuclear and thermonuclear explosives. Underground nuclear detonations for military purposes provide a basis for the theory of cracking and chambering and suggest possible uses.

Explosions contained underground explosions have 4 types: nuclear reaction, hydrodynamic expansion of chamber, quasi-static persistence of the chamber accompanied by flowing and dripping of molten material, longer term vertical collapse of the cavern. Radioactivity of underground explosions in tuff can be contained at a depth of $400W^{1/3}$ ft. where W is the energy release in kilotons. The initial cavity has a radius of $50W^{1/3}$ ft. For a 1-kiloton explosion, 500 tons of glass and 120,000 tons of broken rock are produced. 65 to 80% of the radioactivity is in the steam and about 30% of energy is in steam and rock at a pressure of $1,200^\circ\text{C}$. From these facts 3 nuclear experiments have been designed.

Project Chariot will develop information for large excavations including canals, harbors, reservoirs, strip mines. It will consist of the simultaneous detonation of four 20-kt. explosions at 400-ft. depths and one 200-kt. explosion at 800 ft.

Project Gnome consists of detonating a 10-kt. nuclear explosion in a salt bed. Thirty percent of the energy should be retained as heat in the melted salt and may be used to generate steam. Useful types may be obtained.

Project Oilsand will use entrapped heat of a nuclear explosion to decrease viscosity of oil in rock. A 10-kt. explosion at the base of the Athabasca sand, 100 ft. below the surface, is expected to increase permeability. Radioactive contamination is expected to be well below accepted levels.

Other considered uses include: development of permeable links between ground-water structures and the surface, the recovery of oil from shale, an alternative source for geophysical research, the study of high-temperature and high-pressure phenomena.--an Horn.

2-1885. Landau, Richard E. MATHEMATICAL EXPRESSIONS FOR THE CIRCULAR ARC METHOD OF STABILITY ANALYSIS (In: Landslide and Foundation Investigations and Stability Analysis: Research Council, Highway Research Board, Bulletin 236, p. 39-68, 17 figs., 1960) 6 refs.

This paper deals with the cylindrical failure plane applied to the general solution of earth-slope stability problems. It presents rigorous mathematical expressions which will permit direct application of computer programming as well as to organized

One of the factors affecting the pseudostructures is optical anomaly and anisotropy, appearing in certain definite stages of coal metamorphism and related to the development of finely dispersed mineral inclusions, formed during diagenesis. Principal mineral inclusions are melnikovite-marcasite, pyrite, organic compounds of Fe, and certain others.--Auth.

manual computation for the determination of the weakest failure plane. Simplifying assumptions have been kept at a minimum to utilize fully the accuracy potential of the high-speed computer. Basic equations are presented for solution of the simple stability problem involving a constant earth slope of homogeneous material founded on a stratified subsoil. Special cases are also investigated, involving irregular or stratified slopes, the condition of toe failure, dam analysis, and related refinements demonstrating the flexibility of the derived expressions. In some instances, simplifying assumptions are made; however, it is left to the soils engineer to determine the suitability of the assumptions before attempting to use the equations for any specific problems. Specific examples of the use of these equations in the solution of a typical roadway embankment and an earth dam problem are presented in the appendix. The appendix also contains the basic forms from which the equations presented in the text are derived.--From auth.

2-1886. King, James J. THE THEORY AND PRACTICE OF ROCK BOLTING IN CIVIL ENGINEERING APPLICATIONS: Compass, v. 37, no. 3, p. 198-212, 7 illus., diag., March 1960, 11 refs.

The paper reviews rock bolting and its applications to civil engineering projects. Rock bolting consists of prestressing overhead rock in tunneling operations by using steel in the form of rock bolts and applying tension in them. It has the effect of bolting insecure rock to secure rock to form a safe structure without the use of conventional timbering. Rock bolts have been used as anchor bolts in dams, roof supports in tunnels, stopping slides in rock cuts. Various types and design of bolts and accessories are in use; bolts 1 in. in diameter, slot and wedge anchorage, and lengths of from 4 to 6 ft. are the most common.--M. Russell.

2-1887. Brown, Kermit E., and Frank W. Jessen. EFFECT OF PRESSURE AND TEMPERATURE ON CAVITIES IN SALT: Jour. Petroleum Technology, v. 11, no. 12, p. 341-345, 3 illus., 2 diags., 10 graphs, table, Dec. 1959, 2 refs.

It is deemed feasible to store atomic reactor fuel wastes in salt dome cavities when the differential pressure acting on the cavity does not exceed 3,000 p.s.i. and the temperature is less than 400°F . Tests at pressure increments of 1,000 p.s.i. were conducted on a 2-in. cylindrical cavity contained in a 6-in. long x 6-in. diameter salt core. The cavity exhibited stability under pressures up to 3,000 p.s.i. and temperatures to 300°F . At temperature ranges of 100 to 400°F . and with pressures of 5,000 p.s.i. and above, continuous deformation of the cavity resulted. Initial movement of the salt was observed at all pressures. This was evidenced by vertical deformation and cavity size reduction.--Auth.

2-1888. Muniz, Sotero, Jr. **THE ENGINEERING PROPERTIES OF SANDSTONES:** Compass, v. 37, no. 3, p. 220-233, graphs, tables, March 1960, 6 refs.

This paper outlines a few of the geological properties of sandstones that influence their use as engineering materials. It presents statistics on the properties, analyzes trends, and implies conclusions. Properties presented graphically and briefly discussed include: apparent specific gravity; apparent porosity; compressive strength; modulus of rupture; impact toughness.

2-1889. Wilson, Eldred D. **GEOLOGIC FACTORS RELATED TO BLOCK CAVING AT SAN MANUEL COPPER MINE, PINAL COUNTY, ARIZ. 2. PROGRESS REPORT, APRIL 1956-MARCH 1958:** U.S. Bur. Mines, Rept. Inv. 5561, 43 p., 27 figs. incl. maps, secs., graphs, 10 tables, 1960, 13 refs.

The second in a series of progress reports describing work undertaken at the San Manuel Cu mine to study the geologic factors influencing block caving of the deposit. The first report described the work done from Apr. 1954 to March 1956 [U.S. Bur. Mines, Rept. Inv. 5336, 1957]. This report describes the progress from March 1956 through March 1958 and presents additional maps, factual data, inferences, and conclusions resulting from a continuation of the underground geological work.

As outlined in these reports, the study thus far has shown that the principal geologic factors affecting block caving are structure, rock types, alteration mineralization, oxidation, and presence of water. Structure is fundamentally the most important. Systematic fracturing governed the extent and grade of primary ore mineralization and tangibly affects the subsidence or ground movement, which extends from the mine workings to the surface because of the block caving.--Auth. summ. & introd.

2-1890. Ross, Fred K. **CONTRACTOR MAY COMPLETE HANSON DAM 2 YEARS AHEAD OF SCHEDULE:** Pacific Builder & Engineer, v. 65, no. 12, p. 68-70, 126, 1959.

Howard A. Hanson Dam is a \$25-million flood control project of the U. S. Army Corps of Engineers on the Green River 40 mi. SE. of Seattle, Washington. It will be an earth and rock fill structure 235 ft. high, 730 ft. long at the top, and 800 ft. thick at the base. A side-channel spillway will discharge extreme flood waters, and a tunnel 910 ft. long and 19 ft. in diameter will regulate the flow of the river otherwise.

The tunnel was driven through andesite and some tuff. Several zones of intense alteration and brecciation necessitated steel supports almost throughout. When no soft rock was encountered, the tunnel contractor averaged 30 to 40 ft. of excavation per day. Bad rock at the upper and lower portals together with vertical excavation slopes 150 ft. high compelled the use of rock bolts 20 to 30 ft. long spaced on 5 to 10 ft. centers. In addition 23,000 linear ft. of rock bolts were installed in the outlet works foundation and 12,000 sq. yds. of wire mesh mat protected the workers from falling rocks.--W. N. Laval.

2-1891. Balter, Robert B., and S. Murray Miller. **SOIL AND FOUNDATION INVESTIGATIONS ON THE**

PATAPSCO TUNNEL PROJECT (In: Landslide and Foundation Investigations and Stability Analysis: Natl. Research Council, Highway Research Board, Bull. 236, p. 17-38, 9 illus., 3 maps, sec., 4 profiles, graph, 1960)

The Patapsco Tunnel project comprises a 1.2-mi. twin-tube tunnel under Baltimore harbor and 3.5 mi. of structures in an over-all roadway of 17.6 mi. Numerous areas of questionable soil and foundation conditions were encountered, some of which had not been anticipated before construction. Five of these questionable areas are discussed for their design treatments. Three of the 5 are discussed in more detail in the construction phase. The problems include organic silty clays more than 10 ft. deep; tidal marsh; fill consisting of varied dumped material associated with organic sediments to 35 ft. in depth; intermittent layers of soft compressible soils to a depth of 80 ft.; and miscellaneous shallow fill in a refinery area. The final treatment in certain areas was the result of field observations during construction when subsurface conditions became more clearly defined, a situation which underscores the importance and value of assigning competent field personnel to supervise the soils and foundation aspects of such projects.--M. Russell.

2-1892. Rose, C. W. **SOIL DETACHMENT CAUSED BY RAINFALL:** Soil Sci., v. 89, no. 1, p. 28-35, 7 figs., 3 tables, Jan. 1960, 15 refs.

Experiments on soil detachment by rainfall were carried out to determine the importance of size of raindrops and their impact on soils and the degree to which they effect detachment. Using laboratory-produced rainfall, the relationships between the detachment or dislodgement of soil upon which the rain falls, and the physical characteristics of the rainfall, have been quantitatively investigated for some East African soils. Up to the maximum durations tested, rate of soil detachment under a given rainfall was approximately constant. Rate of soil detachment per unit depended more closely on the momentum per unit area and time of the rain than on its kinetic energy per unit area and time, as has been assumed in the literature.--From auth. summ.

2-1893. Krynine, D. P. **ON THE METHODOLOGY OF LANDSLIDE INVESTIGATIONS IN SOVIET RUSSIA: (In: Landslide and Foundation Investigations and Stability Analysis: Natl. Research Council, Highway Research Board, Bull. 236, p. 1-16, 9 figs., table, 1960) 11 refs.**

The present paper is based on Russian information concerning the landslide investigations done by special field stations located either in the regions with abundant slides or in the vicinity of a large slide in a state of slow motion in which final failure may or may not take place. Slides only, as distinct from falls and flows, are considered in this paper. Russian approaches to the slide classification are discussed first, after which cracks and fissures in the sliding body are considered in detail. Methods of measurement of the displacements at the surface and of those at a depth are described. The paper ends with the methodology of computing the balance of sliding masses at a given slope, the negative balance being generally an indicator of the tendency of the slide to stabilize.--Auth.

15. MISCELLANEOUS

94. Hill, Patrick Arthur. **GENERAL GEOL-
LABORATORY MANUAL:** [192] p., maps,
secs., diags., tables, Ottawa, Carleton
University, 1959, 12 refs.

This manual incorporates laboratory exercises
in the general geology course at Carleton
University, Ottawa, Canada, since 1953. It is not
a textbook. Apart from a classification of the igne-
ous rocks, no textbook material is introduced. The
manual is designed to be used in conjunction with
Swell et al, *Outlines of Geology*, 1941, supple-
mented with specifically listed outside reading. It
contains Canadian and U. S. map exercises.
Selected maps are designated to be studied in detail.
Questions are mixed and not restricted to one topic
exercise.--From auth. foreword.
The manual is organized under the following
principal topics: general, minerals, rocks, topo-
graphic exercises, topographic maps, geologic
exercises, geologic maps, economic geology,
geology, and paleontology.

95. Neustadt, Walter, Jr. **GEOLOGY AND
PUBLIC LIBRARY:** *GeoTimes*, v. 4, no. 7,
13-25, Apr. 1960, 28 refs.

A program of reading in earth sciences is de-
scribed. An appended bibliography lists materials
in age groups from 1st grade to high school. Incent-
ives towards rocks, minerals, fossils, and
maps. Greatly enhanced local interest in geology
has resulted.--R.F. McAllister.

96. Sorgenfrei, Theodor. **GEOLOGY IN DEN-
MARK:** *GeoTimes*, v. 4, no. 7, p. 8-11, 25, 6
Apr. 1960.

Denmark has few geologists but a lively public
interest in geology. After the period of Nicolaus
Steno, in 1667, to the 19th century, geology lan-
guished. In 1888 the Geological Survey was founded.
Studies are restricted by a thick glacial drift cover.
Quaternary geology has a dominant position.
Nevertheless, the late Paleozoic, Mesozoic, and
Cenozoic sedimentary basin beneath the drift has
been extensively studied from water well logs and
oil exploration logs.
Greenland, a Danish territory, and location of the
cryolite deposit, soon to be exhausted after
years of mining, has been extensively studied.
The Geological Survey of Greenland has recently been
founded. Most work has been done on the S., E., and
coastal areas.
The Geological Society of Denmark, the 2 surveys,
mining companies, and the Mineralogical-Geologi-
cal Institute at the University of Copenhagen are the
professional geological groups in Denmark.--
R.F. McAllister.

97. Carnegie Institution of Washington.
**ANNUAL REPORT OF THE DIRECTOR OF THE GEO-
LOGICAL LABORATORY, 1958-1959:** Its: *Geophys.*
Paper no. 1320, 222 p., 65 figs., 30 tables,
approx. 150 refs.; reprinted from: *Carnegie*
Washington, Year Book 58.

A summary of research done at the Geophysical
Laboratory in the following fields: experimentation
with high pressures and temperatures; petrology; ore
minerals; iron meteorites; ages of rocks and miner-
al radioactive fallout, particularly from the Rus-
sian October series; organic geochemistry - kero-
gen testing of steel; optical and electrical properties

of silicates; crystallography; computation of diffrac-
tion effects of short-range ordering in "layered"
sequences.

2-1898. Hunt, Charles B. **GEOLOGIC MAPPING
BY HELICOPTER:** *GeoTimes*, v. 4, no. 7, p. 12-
14, 40, 2 maps, Apr. 1960.

A recent geologic mapping project in Death Valley,
California, was carried out by helicopters. Two-
hundred sq. mi. of extremely rugged topography was
mapped from a helicopter in 50 flying hours, since
bedrock was largely exposed and outcrops easily
traced.

Details of technique, contractual arrangements,
and cost are included, with discussion of the limita-
tions of the method. It is estimated that an aerial
reconnaissance map was made for about 1/3 to 1/4
the cost of ground mapping.--R.F. McAllister.

2-1899. **GEOLOGISTS STUDY MOON FEATURES:**
GeoTimes, v. 4, no. 8, p. 27, May-June 1960.

The first phase of a terrain study of the moon has
been completed by the U.S. Geological Survey and
the U.S. Army Map Service. A map of the moon to
the scale of 1 in. to 80 mi. is being prepared. Mod-
ern stereo-photogeologic methods as well as radar
and geophysical methods have been used.

The origin of the ray system about Copernicus
crater has been attributed to impact of a large mete-
or. Moon surface studies are a necessary step in
preparation for man's landing on the lunar surface,
where conditions for survival are harsh, and may
also help determine the origin and history of lunar
features.--R.F. McAllister.

2-1900. Landen, David. **IMPACT OF THE DEVEL-
OPMENT OF PHOTOGRAMMETRY UPON GEOLOGY:**
Washington Acad. Sci., Jour., v. 49, no. 7, p. 234-
252, 18 illus., 7 maps, diag., July 1959, 9 refs.

The earliest use of photography in support of geo-
logic research was simply to record geologic features
in detail. Perhaps the earliest photographer to ac-
company an expedition was Solomon N. Carvalho who
accompanied John C. Fremont in 1853 across the
Rocky Mountains. A Committee on Photographs,
Geological Society of America, was formed in 1890
and made reference to "photogeologic survey." In
1904, C.W. and F.E. Wright made the first panoram-
ic camera for preparing topographic base maps in
Alaska. The development of aerial photographs for
making maps became possible after the discovery of
the principle of the stereoscopic floating mark in
1892 and the advent of the airplane. The Zeiss multi-
plex aeroprojector became standard U.S. Geological
Survey mapping equipment in 1935; recent improve-
ments involving the same principles are the Kelsh
plotter and the ER-55. Current mapping rate for the
United States is 100,000 sq. mi. annually of 1:24,000
and 1:62,500 maps.

Photogrammetry makes possible a faster rate of
mapping and the establishment of uniform standards
of accuracy for maps of all types of terrain. Ex-
amples of special-purpose maps made more easily
through photogrammetric methods include structure
contour maps, isopachous maps, surface geology
maps, beach erosion studies, mapping of sand beds
in flume tests. Special-purpose photogrammetric
instruments for making quantitative measurements
include the stereometer for measuring parallax
differences, the photogrammetric dip angle indicator

for making direct measurements of dip in the stereoscopic model, and the photogrammetric profile plotter. The orthoscope is capable of producing orthographically restituted photographs wherein the photomap has true scale in all parts.--M. Russell.

2-1901. Beebe, B. Warren. REORGANIZATION OF AGI: *GeoTimes*, v. 4, no. 7, p. 18-20, 33-34, Apr. 1960.

Founding and work of the AGI Reorganization Committee is discussed and reorganization recommendations summarized. The latter include 1) a new name: Institute of Geological Sciences; 2) a new government: management under a proportional representation of member societies arrangement; 3) provisions for certification of qualified members; 4) financing by proportional assessment of member societies based on membership.--R.F. McAllister.

2-1902. INTERNATIONAL GEOLOGY REVIEW: *GeoTimes*, v. 4, no. 7, p. 27-29, chart, Apr. 1960.

Under the AGI translations program, publication of *International Geology Review*, and both the *Izvestiya* and the *Doklady* of the Academy of Sciences, U.S.S.R., has been undertaken. Material in Chinese, Japanese, and other difficult foreign languages is sought. A breakdown of articles by major fields in the first 12 issues (Vol. I) is included, with an organizational chart for the program.--R.F. McAllister.

2-1903. INTERNATIONAL UNION OF GEOLOGY: *GeoTimes*, v. 4, no. 8, p. 8-10, 38-39, May-June 1960.

The British proposal and Draft Statutes of an International Union of Geology are presented as they appear in the Third Circular for the XXI International Geological Congress. A decision on the desirability and feasibility of such a union will be debated.--R.F. McAllister.

2-1904. Tugarinov, A.I. THE TENTH CONGRESS OF MINING ENGINEERS AND METALLURGISTS AT THE FREIBERG MINING ACADEMY: *Geokhimiya* [in translation], 1958, no. 6, p. 774, pub. 1959.

The Congress was held in Freiberg (German Democratic Republic) May 28-31, 1958, and, in addition to East German delegates, was attended by many foreign (including West German) delegates and guests. The reports briefly summarized are:

E. Sadetzky-Kardos (Hungary): Rare elements and geochemistry.

E. Kraus (West Germany): On the asymmetric development of orogenic factors.

E. Bederke (West Germany): On the age of regional metamorphism of the western alps.

Prof. Dimitrov (Bulgaria): On the metamorphic complexes of Bulgaria.

V. Marmo (Finland): Granites and formation of ores.

Prof. Schril (East Germany): Report on redeposition of ores from the Harz deposits.

A.P. Vinogradov, and others (U.S.S.R.): Age of granites and ores of Saxony.--F. Manheim.

2-1905. Saukov, A.A. THE ALL-UNION CONFERENCE ON GEOCHEMICAL AND RADIOMETRIC METHODS OF PROSPECTING AND EXPLORATION

OF OIL AND GAS DEPOSITS: *Geokhimiya* (in translation), 1958, no. 6, p. 771-773, pub. 1959.

This conference was organized by the Academy of Sciences, U.S.S.R., and held in Moscow, Apr. 21-26, 1958. In addition to Soviet representatives, scientists from the German Democratic Republic, Czechoslovakia, Poland, Rumania, and Yugoslavia took part.

Very brief summaries are given of the following report topics:

A.A. Saukov: Report on migration of chemical elements as the theoretical basis of geochemical prospecting for mineral deposits.

V.A. Sokolov: Report on the distribution of C_2 - C_4 hydrocarbons in gases associated with oil accumulations.

S.I. Kuznetsov: Discussion of the principles of microbiological prospecting.

F.A. Alekseev: Report on the theoretical basis of radiometric methods of exploration for oil and gas.

A.I. Silin-Bekchurin: Movement of deep underground waters.

A.B. Ronov: Report on the distribution of organic C in the sedimentary rocks of the Russian platform.

Yu. M. Yurovsky: Progress of gas logging in the U.S.S.R.

In addition, the following reports and reviews are cited by title but not further discussed:

G.A. Mogilevsky: Present state of the problem of gaseous and bacterial anomalies and the rational methods of their identification.

E.A. Bars: Hydrochemical investigations in prospecting for oil and gas.

V.A. Kovda and P.S. Slavin: Soil geochemical indications of oil.

V.N. Florovsky: Luminescent-bituminologic method of study and prospecting for oil and gas deposits.

V.A. Sokolov: Gas-analytical procedures and apparatus and ways in which they are to be improved.

The conference concluded with recommendations for the further development of geochemical and radiometric methods of prospecting and their coordination with other exploratory methods.--F. Manheim.

2-1906. Yavnel, A.A., and B. Yu. Levin. CHRONICLE OF THE TENTH GENERAL ASSEMBLY OF THE INTERNATIONAL ASTRONOMICAL UNION, MOSCOW, AUGUST 1958: *Geokhimiya* [in translation], 1958, no. 7, p. 861-866, pub. 1959.

A summary is given of 2 symposia held on the occasion of the Tenth General Assembly of the International Astronomical Union.

1. Symposium on the evolution of meteoritic matter. The main points of the following papers were summarized:

A.P. Vinogradov: Meteorites and the earth's crust.

V.G. Fesenko: Conditions of the disintegration of asteroids according to data of photometric investigations of zodiacal light.

H. Brown: Distribution of Cr, Mn, Ti, Fe, Co and Ni in meteorites.

F. Whipple: New results of study of meteorites and micrometeorites.

H. Urey: Metallic constituents of chondrites.

A.A. Yavnel: Certain regularities in the composition of meteorites.

L.G. Kvash: On achondrites.

2. Symposium on the origin of the earth and

8. Brief papers were presented by H. Jeffreys, Kuiper, R.L. Ruskol, F. Hoyle, A.I. Lebedin, E. Schatzman, B. Yu. Levin, V.S. Safronov, Urey, V.A. Krat, and T. Gold. Summary of some of the papers and ensuing discussion is given, but no titles are cited.--F. Manheim.

7. AGI VISITING GEOSCIENTIST PROGRAM: *GeoTimes*, v. 4, no. 8, p. 20, 26, May-June 1960.

brief report and list of the 42 AGI visiting geoscientists during 1959-1960, including details of the program and its implementation.--R.F. McAllister.

8. Yalkovsky, Ralph. A SUGGESTED PROGRAM TO MEET THE CRITICAL NEED FOR TEACHERS: *Jour. Geol. Education*, v. 8, no. 1, p. 6-8, May 1960.

The geology department at Montana State University is under consideration a program for teacher training. If adopted, it will permit the candidate to receive the general secondary teaching credential as well as the Master's degree in geological education, thus enabling him to teach in the high school, junior college, or the small liberal-arts college. The ultimate fate of this program and its general acceptance may depend to some degree on the opinion of members of the profession as to its desirability.--

9. Willard, Gates. A NEW ROLL [SIC] FOR THE GRADUATE GEOLOGIST: *GeoTimes*, v. 4, no. 14-15, 34-35, May-June 1960.

Increasing pressure is felt for public school science education. Many schools meet this pressure by using methods of science. The problem-solving approach is recommended over "cook book" laboratory exercises, as the former teaches scientific method. Many good geology graduates could obtain teaching certificates with a few more courses in education and, if competent and interested, could be fine school teachers.

Geology may be introduced in school curricula, perhaps at the expense of general science in many schools, and as part of an earth sciences course. As a new field for good geology students and one which would aid both the geology profession and the general science, earth science teaching may be highly recommended.--R.F. McAllister.

10. Baldwin, Brewster. GROUND-WATER REPORTS FOR OUTSIDE READING IN THE BEGINNING GEOLOGY COURSE: *Jour. Geol. Education*, v. no. 1, p. 9-10, Spring 1960.

Each student in the beginning geology course was assigned a ground-water report to read and summarize. Mimeographed instructions, including an outline of items to note, were supplemented by conferences. Students appreciated the practical application of geology and did not find the reports too technical.--Auth.

11. Campbell, Charles D. AN ADVANCED PHYSICAL GEOLOGY COURSE FOR HIGH-SCHOOL SCIENCE TEACHERS: *Jour. Geol. Education*, v. 8, no. 1, p. 1-5, Spring 1960.

In this 8-week summer institute course, [sponsored by the National Science Foundation in 1958 at

Washington State University], physical geology was presented as an evolution of ideas: newly published research was shown to be dependent upon progressively earlier discoveries. Historically important experiments were reproduced as feasible in the laboratory.--Auth.

2-1912. Dryden, Lincoln. ON TEACHING HISTORICAL GEOLOGY: *Jour. Geol. Education*, v. 7, no. 2, p. 67-70, Fall 1959, 6 refs.

Despite generally excellent conditions for teaching geology, we are confronted by several problems. One is that of a satisfactory textbook. A good text should include extensive treatment of paleontology and genetics, ecology, and correlation by fossils. It should also include sedimentary rocks and sedimentation, for that is where they belong - in historical geology. A second problem is that of laboratory; in this matter we are still experimenting. And our over-all, perennial problem is how to escape from an infinity of factual details.--Auth.

2-1913. Beerbower, James R., and James L. Dyson. WHY TEACH HISTORICAL GEOLOGY?: *Jour. Geol. Education*, v. 7, no. 2, p. 71-74, Fall 1959, 2 refs.

The conventional survey of geologic history during the second semester of the elementary geology course at Lafayette College has failed to fulfill the desired functions of the course. This failure has led to progressive modification of the course plan. Of the various alternatives, the most effective appears to be a study of some of the basic problems of historical geology with reference to critical areas and sequences. This method has been applied to the laboratory portion of the course and is being developed further in the lectures.--Auth.

2-1914. LaFleur, Robert G. HISTORICAL GEOLOGY FOR THE GEOLOGY MAJOR: *Jour. Geol. Education*, v. 7, no. 2, p. 64-66, Fall 1959.

Historical geology has been modified to provide more adequate background for geology majors specializing in petroleum and geophysics. Ways are suggested of adding material in the fields of sedimentary tectonics, structural evolution of provinces, methods of dating, and usage of stratigraphic nomenclature.--Auth.

2-1915. Vitaliano, Dorothy B. FOREIGN LANGUAGES FOR GEOLOGISTS: *Jour. Geol. Education*, v. 7, no. 2, p. 49-53, Fall 1959, 7 refs.

An attempt is made to convince the reader that, given a geological background and a desire to learn, a knowledge of any foreign language, adequate for reading geological papers, is much more easily achieved than generally supposed. With sufficient grounding in 3 languages (French, German, and Russian) the door is opened to nearly all the world's geological literature.--Auth.

2-1916. GEOLOGY-GEOPHYSICS STUDENTS IN THE UNITED STATES AND CANADA IN 1960: *GeoTimes*, v. 4, no. 8, p. 16-19, 2 graphs, 4 tables, May-June 1960.

Tables are presented showing: the total 1960 student enrollment in geology and geophysics in colleges and universities in the United States and Canada compared with 1956, 1957, 1958, and 1959; the 1960 en-

rollment at various academic levels compared with previous years; a summary of all students enrolled in geology courses in geology-geophysics degree-granting institutions in 1960; the 1960 employment outlook of geoscience graduates compared with the 1959 outlook; and graphs of geology-geophysics enrollment trends at various academic levels in 1957-1960 in the United States and Canada. A brief analysis is included.--R. F. McAllister.

2-1917. Bostik, Wayne C. **THE DEPARTMENT OF GEOLOGY, TEXAS TECHNOLOGICAL COLLEGE:** *Compass*, v. 37, no. 4, p. 319-323, May 1960.

The physical plant, library, faculty, and courses of instruction of the Dept. of Geology at Texas Technological College, Lubbock, is described. The department has a staff of 11, offering 55 courses in 14 fields of specialization.--M. Russell.

2-1918. Huang, Walter T. **GEOLOGICAL EDUCATION IN CHINA PRIOR TO 1948:** *Jour. Geol. Education*, v. 8, no. 1, p. 14-17, Spring 1960.

Modern education in China was patterned essentially after that in the United States. Departments of geology existed in all major national and provincial universities before 1948. The B.S. degree in geology was offered, and graduate work leading to the Master's degree was begun in 1940. A rigid undergraduate program of geology courses quite similar to that of American universities was required, but specialized courses such as geophysics, micropaleontology, and petroleum geology were not offered. One of the most important and significant features of the program of geological education in China was the invitation of eminent professors from foreign countries. Chinese students were sent by the government to the United States and Europe for graduate work.--Auth.

2-1919. Goldthwait, Richard P. **TRAINING NEW ZEALAND'S GEOLOGISTS:** *Jour. Geol. Education*, v. 7, no. 2, p. 61-63, Fall 1959.

Although federal surveys and provincial reports were published in New Zealand even earlier than in the United States, and the geological profession has long been established, there are only about 150 geologists in the country. Public interest in geology is strong, because volcanoes, earthquakes, and glaciers are in everyone's experience. Yet only about 20 Bachelor's degrees in geology are awarded each year by the 4 universities. The curriculum concentrates on science, with little attention paid to the humanities or arts. Only about half those who

start to major at "Stage I" finish with a degree in geology. About 7 of these go on to take advanced degrees. This supply more than satisfies New Zealand's need for new geologists.--Auth.

2-1920. DuBar, Jules R. **LEONARDO DA VINCI - THE GEOLOGIST:** *GeoTimes*, v. 4, no. 8, p. 11-13, 37, May-June 1960.

Da Vinci recognized the true origin of fossils and elaborated on the idea. He was variously an early ecologist, paleoecologist, paleontologist, and paleogeographer. He had some idea of processes of fossilization, the work of running water and stream erosion. He appears not have realized the extent of geologic time, however. His major contribution to geology was the idea of basing theory upon observations in the field rather than arm chair geologizing.--R. F. McAllister.

2-1921. **JOB SCARCITY HITS GEOLOGISTS:** *Petroleum Week*, v. 10, no. 20, p. 21-22, May 20, 1960.

This year's crop of new geologists is facing the toughest job situation in 20 years. Oil companies and the U.S. Geological Survey are hiring only on a replacement basis or are reducing staffs. The reasons are 1) world surplus of oil, 2) the many geologists hired in post-war years who, with experience, have become more productive of work, and 3) in the case of the U.S. Geological Survey, retrenchment of the atomic energy program.

Experience is discounted in hiring, as most companies are looking for fresh graduates. However, advanced degrees help and so does emphasis on physics, chemistry, and mathematics.--C. C. McFall.

2-1922. **THE VETLESEN PRIZE:** *GeoTimes*, v. 4, no. 7, p. 16-17, 29, 3 illus., Apr. 1960.

The Vetlesen Prize of a gold medal, \$25,000, and support of publication of the recipient's scientific papers is the earth sciences equivalent of the Nobel Prize, and is offered every 2 years.

Dr. Maurice Ewing, Director of Lamont Geological Observatory, Columbia University, was selected as the first recipient for outstanding contribution in the study of oceanography. Scientists from any country are eligible.

A Vetlesen Lecture by the nominee was titled, "The Mechanics of the Mid-Ocean Ridge and Rift," and was later discussed by distinguished earth scientists invited for the occasion.--R. F. McAllister.

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